SACRAMENTO METROPOLITAN

AIR QUALITY
MANAGEMENT DISTRICT

5-YEAR AIR MONITORING NETWORK ASSESSMENT

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Executive Summary

In accordance with 40 CFR Part 58.10(d), the Sacramento Metropolitan Air Quality Management District (District) is required to submit to the United States Environmental Protection Agency (EPA) an assessment of the air quality surveillance system. A network assessment was performed using five years of data between 2015 to 2019 to determine if the monitoring network is meeting the required monitoring objectives of 40 CFR Part 58, which are:

1. Provide air pollution data to the general public in a timely manner.
2. Support compliance with ambient air quality standards and emissions strategy development.
3. Support for air pollution research studies.

This assessment follows a top-down methodology to determine whether the existing ambient air monitoring network meets the needs of the residents of Sacramento County and District's monitoring objectives. The District is the local air quality regulatory and monitoring organization with jurisdiction over Sacramento County, California. Sacramento County has a population of approximately 1.5 million persons[1] and is located in the southern portion of the Sacramento Valley air basin[2] (Figure 1).

The District is committed to effectively reducing exposure to air pollution and protecting public health within Sacramento County. As a direct result of these commitments, the District has been, and remains involved in, various monitoring efforts not required as part of any federal monitoring requirements with many agencies, companies, and non-profit organizations. These efforts can provide valuable information, which can be used to support meeting the District's monitoring objectives including providing timely information to the public, developing emission reduction strategies, and supporting air pollution research studies.

Sacramento County is included in the Sacramento Federal Ozone Nonattainment Area (SFNA; 56 FR 56728), and the SFNA is a nonattainment area for the federal 8-hr ozone (O_3) standard (83 FR 25776). The Sacramento region was also designated as nonattainment for the 2006 24-hour fine particulate matter ($PM_{2.5}$) standard. The region met the 2006 24-hour $PM_{2.5}$ standard in 2015 (82 FR 21711), but the Sacramento Federal $PM_{2.5}$ Nonattainment Area (74 FR 58688) has not yet been redesignated to attainment. See Figure 1 for boundaries of these two areas. Sacramento County has met the coarse particulate matter (PM_{10}) air quality standard since 2002[3]. Sacramento County is designated as attainment for the most recent federal health standards for carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). EPA has designated Sacramento County as unclassifiable/attainment for the 2008 federal lead (Pb) standard (70 FR 72097).

[1] United States Census Bureau: https://www.census.gov/quickfacts/sacramentocountycalifornia
[2] California air basins as defined by the California Air Resources Board (CARB): https://www.arb.ca.gov/ei/maps/2017statemap/zabmap.htm
[3] The 2018 Camp Fire caused PM_{10} exceedances, and the District has submitted to EPA an exceptional event demonstration to exclude the data from air quality standard comparison. More information can be found in the PM_{10} section of this assessment.

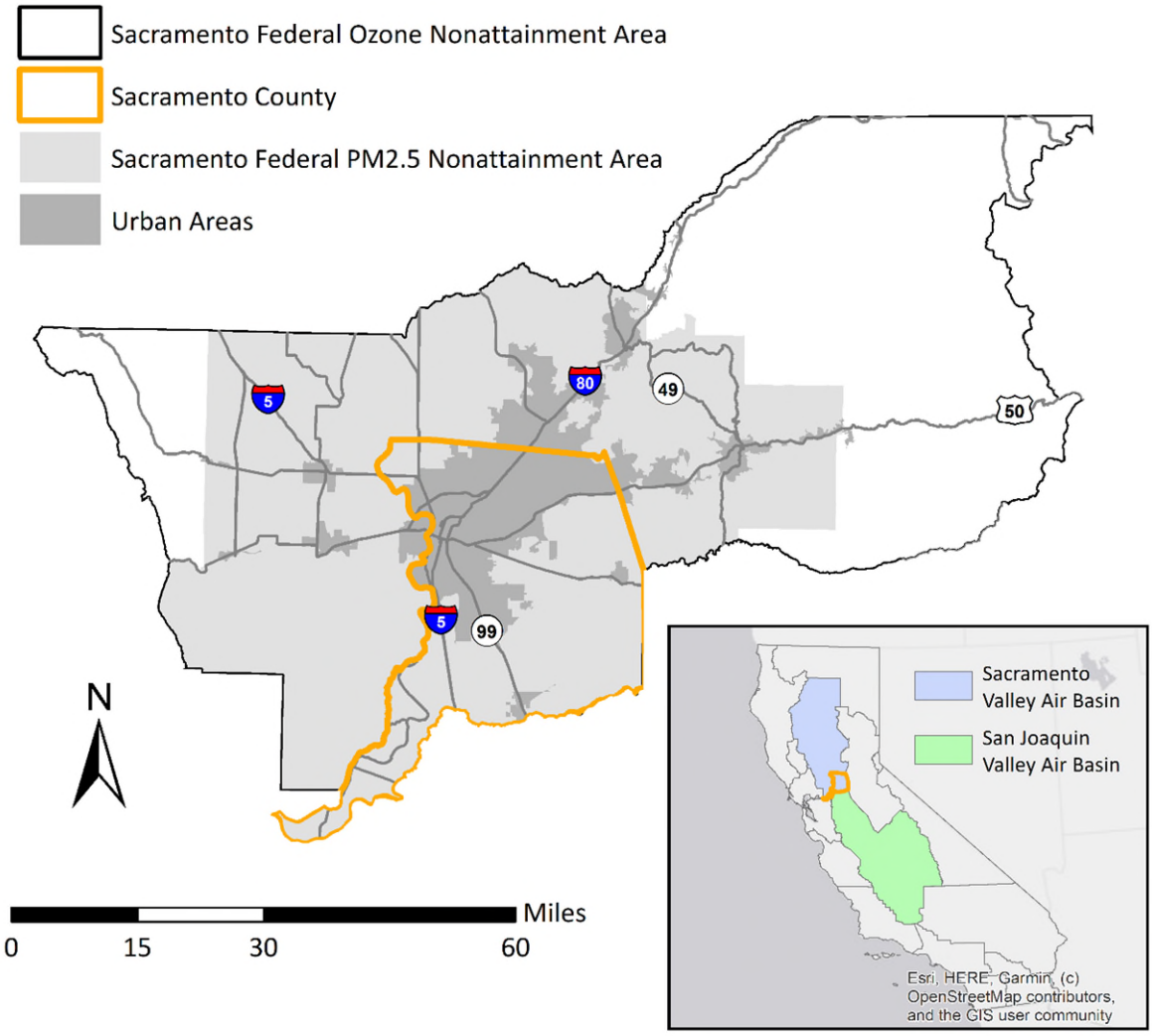


Figure 1 – Map of Sacramento County, the urban areas within and close to Sacramento County, the Sacramento Federal Ozone Nonattainment Area, the Sacramento Federal $PM_{2.5}$ Nonattainment Area, and the Sacramento and San Joaquin Valley air basins.

A reliable air quality network provides essential information to help protect the health and welfare of the public. Therefore, it is important to evaluate whether an air quality network continues to meet health based regulatory requirements and to assess whether the monitoring network continues to meet objectives as air quality conditions and distribution of emissions change over time.

It is reasonable to suspect that sites vary in importance to the District network based on a number of factors critical in defining air quality for the region. This assessment investigates how the network can be improved upon based on criteria set forth in 40 CFR part 58.10(d) and the EPA Ambient Air Monitoring Network Assessment Guidance[4]. However, as this assessment investigates whether the current network adequately meets the monitoring objectives defined in 40 CFR Appendix D to Part 58, it

[4] US EPA, Ambient Air Monitoring Network Assessment Guidance Documents; https://www.epa.gov/amtic/ambient-air-monitoring-network-assessment-guidance-documents

is important to assess whether new sites are needed or monitors are suitable for relocation or discontinuation within the network and District resources.

The methodology used in this assessment is based on a subset of the analysis methods prescribed in EPA's Network Assessment Guidance document[5]. The Clean Air Act requires the EPA to set health standards for six criteria air pollutants: O_3, particulate matter, CO, Pb, SO_2, and NO_2. These pollutants are called criteria pollutants as the health standards are set based on the characterizations of the latest scientific information regarding their effects on health or welfare[6]. Each criteria pollutant monitor was analyzed and ranked for importance based on the following analysis techniques.

- **Area-Served** – Monitors with the largest areas of influence were ranked highest.
- **Population-Served** – Monitors serving the largest total population were ranked highest.
- **Measured Concentration** – Monitors with higher design values were ranked highest.
- **Deviation from NAAQS** – Monitors closest to the NAAQS were ranked highest.
- **Trend Impact** – Monitoring sites with the longest active historical record were ranked highest.
- **Monitor-to-Monitor Correlation** – Monitors were ranked by considering correlation based on Pearson coefficients, distance between sites, and mean difference in concentrations. Monitors with low correlation, large proximities, and high absolute differences are ranked highest.
- **Removal Bias** – Monitors having the highest change in concentration when removed from the network were ranked highest.

An additional analysis was performed for the District network as a whole. The Number of Parameters technique which the total number of parameters measured at each site. Sites at which many parameters are measured ranked highest. All analyses listed above were performed for each pollutant, and individual monitors within those sampling the pollutants were ranked based on each of the analysis techniques. Each monitor was ranked for importance based on the specific analysis technique. An overall score was then calculated for each monitor. The monitors with the lowest total scores were examined carefully to identify network redundancies or possible relocation. The results of the analyses were evaluated in context of the overall monitoring objectives for each pollutant. Recommendations for the network were made based on the aggregated results of the analysis identified above. Below are the major recommendations from this assessment.

- Installation of a replacement air monitoring station near the discontinued North Highlands-Blackfoot location to measure PM_{10} concentrations and if resources are available, ozone concentrations.
- Discontinuation of the Sacramento-Branch Center #2 PM_{10} filter-based monitor and the Sacramento-Branch Center #2 air monitoring station if a replacement air monitoring station has been installed for the North Highlands-Blackfoot location.
- Installation of a continuous PM_{10} monitor at the Elk Grove-Bruceville site.
- Installation of the Photochemical Assessment Monitoring Stations (PAMS) equipment required in 40 CFR Appendix D to Part 58 after the Sacramento-Del Paso Manor station expansion project is completed. The existing PAMS VOC canister sampling will be replaced with an automated gas

[5] US EPA Ambient Air Monitoring Network Assessment Guidance, Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks, EPA-454/D-07-001, February 2007.
[6] US EPA, Criteria Air Pollutants; https://www.epa.gov/criteria-air-pollutants.

chromatograph (autoGC). An ultraviolet radiation sensor, precipitation gauge, and barometric pressure sensor will also be installed.

- The Sacramento area has surpassed the threshold for a second near-road monitoring site to measure NO_2 and CO. The District is working with EPA and CARB to determine the appropriate timing, location, and funding for this site.

Table of Contents

List of Figures

List of Tables

List of Definitions

µg m^{-3}	micrograms per cubic meter
AADT	annual averaged daily traffic
AB 617	Assembly Bill 617
AQI	Air Quality Index
AQS	Air Quality System
autoGC	automated gas chromatograph
CAL FIRE	California Department of Forestry and Fire Protection
CARB	California Air Resources Board
CBSA	Core Based Statistical Areas
CFR	Code of Federal Regulations
CNRA	California Natural Resources Agency
CO	carbon monoxide
CSN	Chemical Speciation Network
District	Sacramento Metropolitan Air Quality Management District
DV	design value
EE	Exceptional Event Rule
EMP	Enhanced Monitoring Plan
EPA	United States Environmental Protection Agency
FEAADT	Fleet Equivalent Annual Average Daily Traffic
FEM	federal equivalent method
FR	Federal Register
FRM	federal reference method
ID	identification
IMPROVE	Interagency Monitoring of Protected Visual Environments
km	kilometers

MODIS	Moderate Resolution Imaging Spectroradiometer
MSA	Metropolitan Statistical Areas
NAAMS	National Ambient Air Monitoring Strategy
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NCore	National Core Multi-Pollutant Monitoring Stations
NEI	National Emission Inventory
NO_2	nitrogen dioxide
NOx	oxides of nitrogen
NOy	Reactive nitrogen compounds
O_3	ozone
OAQPS	EPA Office of Air Quality Planning and Standards
PAMS	Photochemical Assessment Monitoring Stations
Pb	lead
PM_{10}	coarse particulate matter (diameter less than or equal to 10 micrometers)
$PM_{10-2.5}$	particulate matter with diameter between 10 and 2.5 micrometers
$PM_{2.5}$	fine particulate matter (diameter less than or equal to 2.5 micrometers)
ppb	parts per billion
ppm	parts per million
PQAO	Primary Quality Assurance Organizations
PWEI	population weighted emission index
R	Pearson correlation coefficient
SACOG	Sacramento Area Council of Governments
SFAD	Sacramento Federal $PM_{2.5}$ Area Designation
SFNA	Sacramento Federal Ozone Nonattainment Area
SIP	State Implementation Plan
SLAMS	State and Local Air Monitoring Stations

SO_2	sulfur dioxide
SPM	Special Purpose Monitoring
USCB	United States Census Bureau
VOC	volatile organic compound

Station Abbreviations

BC	Sacramento-Branch Center #2
BER	Sacramento-Bercut Drive
BRU	Elk Grove-Bruceville
DPM	Sacramento-Del Paso Manor
FOL	Folsom-Natoma St.
NH	North Highlands-Blackfoot
SLU	Sloughhouse
TST	Sacramento-1309 T Street

Introduction

In October 2006[7], the U.S. Environmental Protection Agency (EPA) finalized amendments to the ambient air monitoring regulations. The goal of the amendments was to enhance ambient air monitoring networks to better serve current and future air quality management and research needs. As part of the amendments, EPA required that states or local air monitoring agencies conduct a network assessment once every five years to determine, at a minimum, if the air monitoring network meets the air monitoring objectives as defined in Title 40 Code of Federal Regulations (CFR) Part 58, Appendix D. This requirement is an outcome of implementing the 2005 National Ambient Air Monitoring Strategy (NAAMS). The purpose of the NAAMS is to optimize air monitoring networks to achieve the best possible scientific value and protection of public and environmental health and welfare utilizing limited resources. Per 40 CFR 58.10(e):

> *"(e) The State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. For $PM_{2.5}$, the assessment also must identify needed changes to population-oriented sites. The State, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan, to the Regional Administrator. The first assessment is due July 1, 2010."*

To satisfy the requirements of 40 CFR Part 58.10(e), the Sacramento Metropolitan Air Quality Management District (District) performed this assessment of the District air and meteorological monitoring networks for the five-year period from 2015-2019. This assessment revisits the findings of and builds upon the District's 2015 Air Monitoring Network Assessment[8]. The methodology and techniques used in the assessment are a subset of the analysis methods prescribed in EPA's network assessment guidance document[9].

[7] US EPA Revisions to Ambient Air Monitoring Regulations; Final Rule, FR Vol. 71, No. 200, October 17, 2006.
[8] Sacramento Metropolitan Air Quality Management District, 2015 Air Monitoring Network Assessment, http://www.airquality.org/ProgramCoordination/Documents/2015%20Air%20Monitoring%20Network%20Assessment.pdf.
[9] US EPA Ambient Air Monitoring Network Assessment Guidance, Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks, EPA-454/D-07-001, February 2007.

Background

Since ambient monitoring objectives, regulatory requirements, and demographics change over time, air agencies need to reevaluate and potentially reconfigure their monitoring networks to best meet the needs of these changes. Several factors to consider when assessing the network include the following:

- Changes in air quality monitoring requirements
- Improvements in air quality,
- Changes in population and behaviors, and
- Advances in scientific understanding of air quality.

This assessment reviews the adequacy of the air monitoring network and helps to determine how the network can be improved upon and efficiency of the network increased wholistically. This includes assessing if some areas have unnecessary or redundant monitors or lack the necessary monitors altogether. Changes to the National Ambient Air Quality Standards (NAAQS) motivate air agencies to examine their monitoring activities and to prioritize monitoring resources on pollutants of interest, such as ozone (O_3) and its precursors and fine particulate matter (diameter less than or equal to 2.5 microns in size; $PM_{2.5}$).

Agencies are intentional in designing networks that protect the public and the environment while maintaining the ability to understand long-term historical air quality trends. Air quality trends are integral in understanding the efficacy of pollutant reduction strategies as well as identifying long term factors impacting air quality such as climate change. Air monitoring agencies can also take advantage of improved scientific understanding of air quality issues as well as implement new air monitoring technologies into their monitoring networks.

Monitoring networks should be designed to address multiple, interrelated air quality issues and to support other types of air quality assessments, such as emission inventory assessments or photochemical modeling. Agencies need to effectively utilize extremely limited federal and state resources to maximize the outputs of the air monitoring networks to meet the needs of current air quality issues or research will enhance their value to protect the general public, stakeholders, and scientists.

Network Objectives

Sacramento County is located within the southern portion of the Sacramento Valley (Figure 2). The objectives of the District air monitoring stations are to collect ambient air quality and meteorological data to be used for several purposes as outlined in 40 CFR Appendix D to Part 58:

- To provide the public with air quality information that includes air quality forecasts, air quality episodes that affect public health, and current air quality conditions.
- To establish regulatory compliance with ambient air quality standards.
- To develop a scientific understanding of air quality, including spatial and temporal distribution of emissions, historical trends in air quality, identification and quantification of emission source contributions, input to and evaluation of air quality models, population exposure to poor air quality, and design and evaluation of the effectiveness of control strategies.

The goal of the District's monitoring network is to ensure that its network is capable of effectively characterizing air quality and meteorology in the county and that it continues to meet its monitoring objectives.

Figure 2 – Map of Sacramento County.

The District is the public agency responsible for development, implementation, monitoring, and enforcement of various air pollution control strategies in Sacramento County, including its incorporated cities. This includes meeting monitoring objectives as set forth by federal air monitoring standards. For ozone (O_3) and fine particulate matter ($PM_{2.5}$), the District is part of larger federal non-attainment areas (see Figure 3), which includes Sacramento County and portions of El Dorado, Placer, Solano, and Yolo counties[10]. The Sacramento Federal Ozone Nonattainment Area (SFNA) is designated by the EPA as severe non-attainment for the 1997 and 2008 8-hour O_3 standards, and serious for the 2015 8-hour O_3 standard (86 FR 59648). Although the concentrations remain above the 2015 federal standard of 70 ppb at several monitoring stations, ozone concentrations continue to steadily decrease in the nonattainment area. The region continues to reduce concentrations through implementation of programs and

[10] The southern portion of Sutter County is included as part of the Sacramento Federal Ozone Nonattainment Area.

strategies, and the air districts in the SFNA and CARB continue to evaluate the impacts that exceptional events might have on ozone concentrations.

The Sacramento region was also designated as nonattainment for the 2006 24-hour and in attainment for the annual fine particulate matter ($PM_{2.5}$) standards. The region as shown in Figure 3, met the 2006 24-hour $PM_{2.5}$ standard in 2015 (82 FR 21711) and is continuing to reduce $PM_{2.5}$ levels through various programs and strategies. Sacramento County has met the particulate matter with size of 10 microns or smaller (PM_{10}) air quality standard since 2002[11]. The District has prepared a Second 10-year Maintenance Plan for Sacramento County that shows maintenance of the 24-hour PM_{10} NAAQS from 2024 through 2033[12]. Sacramento County is in attainment for the federal carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) standards. The EPA designated Sacramento County as unclassified for the 2008 federal lead (Pb) standard[13].

[11] The 2018 Camp Fire caused PM_{10} exceedances, and the District has submitted to EPA an Exceptional Event Demonstration to exclude the data from air quality standard comparison. More information can be found in the PM_{10} section of this assessment.

[12] Second 10-Year PM_{10} Maintenance Plan for Sacramento County; https://www.airquality.org/air-quality-health/air-quality-plans/federal-planning

[13] US EPA, Region 9 (2011), Letter to California Governor Brown and CARB. 14 June 2011. Print. Document can be accessed at https://www.epa.gov/lead-designations/lead-designations-california-state-recommendations-and-epa-responses.

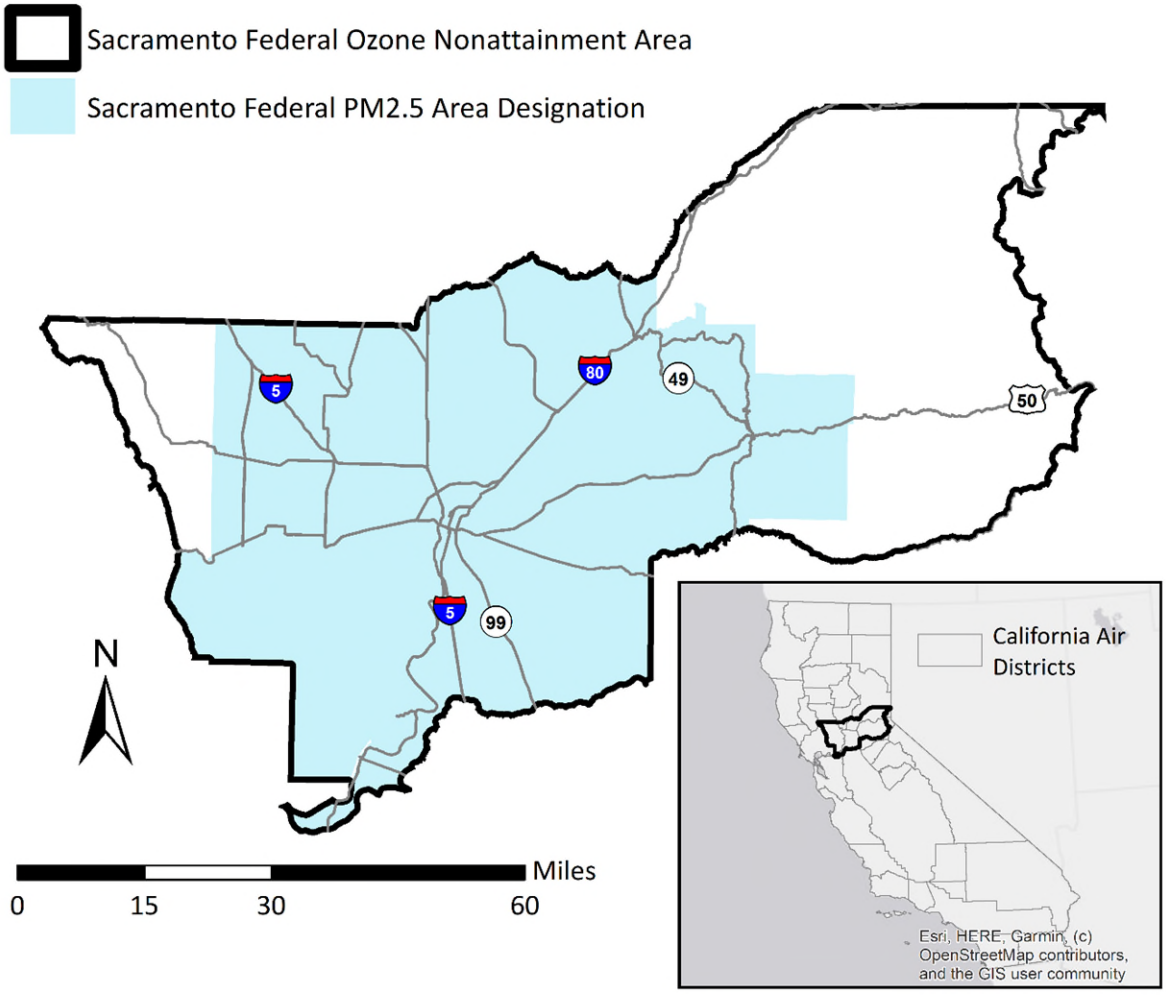


Figure 3 – Sacramento Federal Ozone Nonattainment Area (SFNA) and the Sacramento Federal $PM_{2.5}$ Area Designation. Inset shows all California Air District boundaries with the SFNA overlaid in black.

There are seven (7) air monitoring sites currently operated by the District. An eighth monitoring site, Sacramento-1309 T Street, is currently operated by the California Air Resources Board (CARB). Figure 4 presents the locations of the stations within the County and the population density by census tract from 2010 Census data[14]. Table 2 also provides site network affiliation and station start date. Table 3 presents, by station, the air quality and meteorological parameters measured at each site. Throughout this assessment, monitoring types are listed (e.g. background, population oriented, high concentration) consistent with 40 CFR Appendix D to Part 58. Each District monitoring site has monitors that belong to one or more of the following national monitoring networks:

- SLAMS – State and Local Air Monitoring Stations
- NCore – National Core Multi-Pollutant Monitoring Stations
- CSN – Chemical Speciation Network

[14] Data found at: https://www.census.gov/en.html

- PAMS – Photochemical Assessment Monitoring Stations
- SPM – Special Purpose Monitoring

State and Local Air Monitoring Stations (SLAMS) are used for supplying general monitoring data for criteria pollutants and determining compliance with the NAAQS. The SLAMS are long-term stations that must meet and follow specific quality assurance, monitoring methodology, sampling objectives and siting requirements. The District SLAMS stations have been established with the purpose of determining compliance with NAAQS for the protection of public health. Due to the proximity of ambient air pollutant concentrations to the NAAQS in Sacramento County, a primary focus of the current ambient air monitoring network is the collection of particulate matter, O_3, and photochemical pollutant precursors such as oxides of nitrogen (NOx) and volatile organic compounds (VOC). These data are used to ensure improvement to air quality and public health by supporting state implementation plan (SIP) development, attainment/non-attainment decisions, air quality modeling efforts, and public notification.

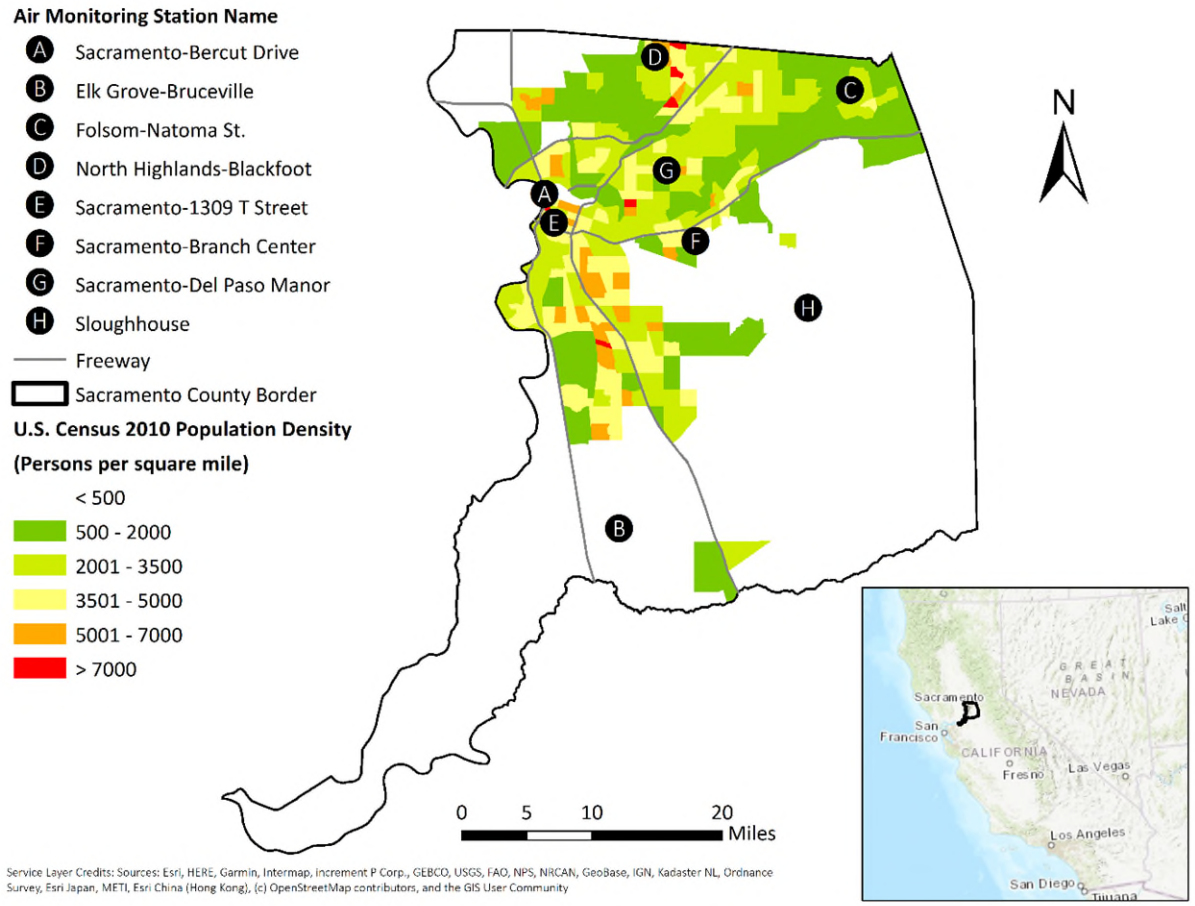


Figure 4 – Locations of District air monitoring stations and 2010 US Census population density. Note that the Sacramento-1309 T Street air monitoring station is operated by the California Air Resources Board.

The District operates one of the 80 National Core Multi-Pollutant Monitoring Stations (NCore) and one of 132 nation-wide $PM_{2.5}$ Chemical Speciation Network (CSN) monitors. 40 CFR Part 58, Appendix D defines NCore criteria as the following: “The NCore multipollutant sites are sites that measure multiple

pollutants in order to provide support to integrated air quality management data needs. NCore sites include both neighborhood and urban scale measurements in general, in a selection of metropolitan areas and a limited number of more rural locations."

In addition to the criteria pollutants, the District operates three (3) Photochemical Assessment Monitoring Stations (PAMS) due to the ozone non-attainment classification. Currently, there are one of each PAMS type I, II, and III sites. However, as part of the 2015 Ozone National Ambient Air Quality Standard review[15], significant changes were made to the PAMS requirements[16] including calling for ozone precursor measurements to be made at existing NCore sites in Core Based Statistical Areas (CBSA) of over 1 million population. Sacramento County is required to have its NCore site be the primary PAMS monitoring station. More information on this can be found in the PAMS section of this assessment.

Special Purpose Monitoring (SPM) stations are also part of the District's monitoring network. SPM stations provide additional information needed by state and local air quality agencies to support air program activities and fulfill the objectives of the air monitoring network. The District operates a single SPM station at North Highlands-Blackfoot and a SPM black carbon monitor at the Sacramento-Del Paso Manor station.

Station abbreviations are used throughout this assessment are outlined in Table 1.

Table 1 – Abbreviation used in this document for District monitoring stations.

Site Name	Abbreviation
Sacramento-Branch Center #2	BC
Sacramento-Bercut Drive	BER
Elk Grove-Bruceville	BRU
Sacramento-Del Paso Manor	DPM
Folsom-Natoma St.	FOL
North Highlands-Blackfoot	NH
Sloughhouse	SLU
Sacramento-1309 T Street	TST

Minimum Monitoring Requirements

The minimum number of monitoring sites required for each pollutant is based on one or more applicable factors, as described in 40 CFR Part 58, Appendix D. These factors include: MSA population, CBSA population, pollutant design value, pollutant maximum concentration, attainment status, annual averaged daily traffic (AADT), SIP, maintenance plan, population weighted emission index (PWEI), and EPA's national emission inventory (NEI) data.

[15] EPA, Ozone Air Quality Standards; https://www.epa.gov/naaqs/ozone-o3-air-quality-standards
[16] Code of Federal Regulations; https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&mc=true&r=PART&n=pt40.6.58#ap40.6.58.0000_0nbspnbspnbsp.d

Federal minimum monitoring requirements (40 CFR, Part 58, Appendix D) were evaluated for the Sacramento–Roseville–Arden-Arcade MSA which, according to the 2020 United States decennial census[17], has a population of approximately 2.4 million persons. The District's jurisdiction is Sacramento County, which is part of the Sacramento MSA, with an estimated population in 2020 of approximately 1.6 million persons[17]. It is the responsibility of the District to meet the minimum monitoring requirements. However, even though the District may meet or exceed monitoring requirements, once sites are established, site discontinuation is in most cases are subject to EPA discontinuation requirements and concurrence under 40 CFR §58.14(c).

Recent Notable Modifications to the Network

In July 2019, due to structural degradation, EPA approved the District's recommendation to demolish the Folsom-Natoma St. air monitoring station and reconstruct in the footprint of the old shelter. The reconstruction of the air monitoring station was completed in December 2020. The District resumed operations of all instrumentation with some exceptions for PAMS monitoring. More details on these exceptions can be found in the PAMS section of this assessment.

On April 20, 2020, EPA approved the District's request to discontinue operation of the carbon monoxide (CO) monitor at North Highlands-Blackfoot and the lead (Pb) monitor at Sacramento-Del Paso Manor. The District discontinued the CO monitor on May 20, 2020, and the Pb monitor on May 31, 2020.

In late July 2022, the District was given a notice to promptly vacate the area where the North Highlands-Blackfoot air monitoring station was located and remove the station from the premises. The District notified EPA of the discontinuation of all remaining monitors at this location (ozone, coarse particulate matter, and nitrogen dioxide). The last day of monitoring operation was July 31, 2022. This assessment will discuss further on whether a replacement station is recommended.

[17] United States Census Bureau, 2020 Census Redistricting Data (Public Law 94-171)

Table 2 – List of District air monitoring stations, site network affiliation, and established date.

Site Name	AQS ID	Latitude (°)	Longitude (°)	Site Network Affiliation						Date Established
				SLAMS	PAMS	CSN	NCore	NR	SPM	
Sacramento-Branch Center #2	06-067-0284	38.55351	-121.33714	X						04/01/2006
Sacramento-Bercut Drive	06-067-0015	38.59333	-121.50373	X				X		11/08/2015
Elk Grove-Bruceville Rd.	06-067-0011	38.30263	-121.42085	X	X*					07/01/1992
Sacramento-Del Paso Manor	06-067-0006	38.61380	-121.36801	X	X	X	X		X	01/01/1980
Folsom-Natoma St.	06-067-0012	38.68330	-121.16446	X	X*					06/01/1996
North Highlands-Blackfoot	06-067-0002	38.71209	-121.38109	X					X	01/01/1980
Sloughhouse	06-067-5003	38.49448	-121.21113	X					X	07/01/1997
Sacramento-1309 T Street	06-067-0010	38.56844	-121.49311	X		X				12/01/1988

SLAMS – State/Local Air Monitoring Stations
PAMS – Photochemical Assessment Monitoring Station
CSN – Chemical Speciation Network
NCore – National Core Multi-Pollutant Network
NR – Near-Road
SPM – Special Purpose Monitor

* As of the 2015 review of National Ambient Air Quality Standards for Ozone (80 FR 65292), this station is not required to report PAMS measurements.

Table 3 – Parameters measured at District monitoring stations.

Site Name	Parameters
Sacramento-Branch Center #2	24-hr PM_{10}
Sacramento-Bercut Drive	CO, NO_2, 24-hr $PM_{2.5}$, Black Carbon, Outdoor Temperature, Wind Direction, Wind Speed
Elk Grove-Bruceville	O_3, NO_2, VOC, Total NMHC, hourly $PM_{2.5}$, Outdoor Temperature, Relative Humidity, Wind Direction, Wind Speed, Solar Radiation, Ultraviolet Radiation, Barometric Pressure, Precipitation, UA Profiler
Sacramento-Del Paso Manor	O_3, CO, NO_2, SO_2, Total NMHC, Hourly PM_{10}, Hourly $PM_{2.5}$, 24-hr $PM_{2.5}$, speciated $PM_{2.5}$, $PM_{10-2.5}$, Black Carbon, NOy, VOC, Carbonyl, Outdoor Temperature, Relative Humidity, Wind Direction, Wind Speed, Solar Radiation
Folsom-Natoma St.	O_3, NO_2, VOC, NOy, Total NMHC, Hourly $PM_{2.5}$, Outdoor Temperature, Relative Humidity, Wind Direction, Wind Speed, Solar Radiation
North Highlands-Blackfoot	O_3, CO, NO_2, 24-hr PM_{10}
Sloughhouse	O_3, Hourly $PM_{2.5}$, Wind Direction, Wind Speed
Sacramento-1309 T Street	O_3, NO_2, Hourly PM_{10}, Hourly $PM_{2.5}$, 24-hr $PM_{2.5}$, speciated $PM_{2.5}$, Outdoor Temperature, Relative Humidity, Wind Direction, Wind Speed

Technical Approach

The overall technical approach for the network assessment was centered on two types of measurements:

- Ambient air monitoring of criteria pollutants
- Meteorological and PAMS networks.

For each of these two types of measurements, several analyses were performed to determine the contribution to the overall network's effectiveness. The results of the analyses were reviewed and evaluated by stations and for their contributions to the network in its entirety. Recommendations for adjustments to the overall network are presented in the Summary and Recommendations section of this assessment. PAMS network recommendations follow EPA guidance as found in Appendix D to 40 CFR Part 58.

A list of network assessment analyses utilized is presented below. The analysis methods are described in detail in EPA's Ambient Air Monitoring Network Assessment Guidance[18] (Network Assessment

[18] EPA, "Ambient Air Monitoring Network Assessment Guidance, Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks": https://www.epa.gov/amtic/ambient-air-monitoring-network-assessment-guidance-documents.

Guidance). The number of parameters monitored analysis was performed first for the District entire network, then the rest of the analyses were performed on a pollutant specific basis. The results of the number of parameters monitored analysis are incorporated into the pollutant specific conclusions in the Summary and Recommendations section of this assessment. The analysis techniques were applied to criteria pollutants only.

Below is a list of the pollutant-specific analyses included in the site-to-site assessment. The Number of Parameters technique is not included in this list as it is calculated for the District network as a whole and is included in its own section. Each of these analyses will be discussed in further detail in the Analyses section.

- Area-Served
- Population-Served
- Measured Concentration
- Deviation from NAAQS
- Trend Impact
- Monitor-to-Monitor Correlation
- Removal Bias

The analyses were performed for each pollutant, and individual monitors within those sampling the pollutants were ranked based on each of the analysis techniques. Each monitor was ranked as high, medium, or low importance based on the analysis technique. An overall ranking was calculated for each site for each pollutant by assigning a value to each rank (1 – low, 2 – medium, 3 – high) and summed over all analyses to provide a score. The monitors with the lowest total scores were examined carefully to identify network redundancies or possible relocation. The results of the analyses were evaluated and viewed in light of the overall monitoring objectives for each pollutant. Recommendations for the network were made based on the aggregated results and are found in the Summary and Recommendations section of this document.

Sources of Data

Ambient air monitoring, meteorological, emissions, and population data were obtained from several sources such as but not limited to:

- the District database,
- National Oceanic and Atmospheric Administration (NOAA),
- United States Census Bureau (USCB), and
- EPA.

The primary data source for air monitoring stations within the District's air monitoring network was EPA's Air Quality System (AQS) database, which was accessed through the EPA web application[19] or the EPA's Network Assessment application tool (NetAssess2020 v1.1). EPA's Office of Air Quality Planning and Standards (OAQPS) developed NetAssess2020 v1.1 and has made it available to all agencies. It is available for use at: https://sti-r-shiny.shinyapps.io/EPA_Network_Assessment/. The tool includes data from AQS as well as other EPA resources to calculate many analyses described in the following section.

[19] EPA Air Quality System (AQS): https://aqs.epa.gov/aqs/

Raw data for criteria pollutants for each District monitoring station that were not available through NetAssess2020 v1.1 were downloaded from AQS.

To evaluate population characteristics within Sacramento County, unless otherwise specified spatially resolved population data were obtained from NetAssess2020 v1.1 or directly from the USCB[20].

Analyses of Ambient Monitoring Data

A comprehensive statistical analysis of the monitoring data was performed to identify potential redundancies of the monitoring data and/or to determine the adequacy of the existing monitoring sites.

Many of the analyses applied in this assessment require the calculation of pollutant design values. A design value is the mathematically determined pollutant concentration at a particular site that must be reduced to, or maintained at or below, the NAAQS to assume attainment. Calculation methods for each pollutant and averaging period are found in 40 CFR Part 50, Appendices A through U. The period that was evaluated for this assessment was the five-year period from 2015 through 2019. Data may be presented for dates earlier than this range, but those are contextual only. For each pollutant in this assessment, tables are included, which provide the design value(s) obtained from AQS. A list of the current NAAQS is found on EPA's NAAQS website[21] and is summarized in Table 4.

Data analysis methods follow the Network Assessment Guidance and are outlined below. The Network Assessment Guidance is designed to be flexible and expandable to meet the needs of air quality planning agencies. Therefore, in some analyses where specific thresholds for monitor importance were not provided by the Network Assessment Guidance, the District developed and applied thresholds suitable to Sacramento County.

[20] Data found at https://www.census.gov/data/data-tools.html

[21] EPA NAAQS table: https://www.epa.gov/criteria-air-pollutants/naaqs-table

Table 4 – EPA National Ambient Air Quality Standards (NAAQS).

Criteria Pollutant	Averaging Period	NAAQS	Form
Carbon Monoxide (CO)	1 hour	35 ppm	Not to be exceeded more than once per year
	8 hours	9 ppm	
Lead (Pb)	Rolling 3-month Average	0.15 µg/m^3	Not to be exceeded
Nitrogen Dioxide (NO_2)	1 hour	100 ppb	98th percentile of 1-hr daily maximum concentration averaged over 3 years
	1 year	53 ppb	Annual mean
Ozone (O_3)	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hr concentration averaged over 3 years
Particulate Matter ($PM_{2.5}$)	24 hours	35 µg/m^3	98th percentile averaged over 3 years
	1 year (Primary)	12 µg/m^3	Annual mean averaged over 3 years
	1 year (Secondary)	15 µg/m^3	
Particulate Matter (PM_{10})	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	1 hour	75 ppb	99th percentile of 1-hr daily maximum concentration averaged over 3 years
	3 hours (Secondary)	0.5 ppm	Not to be exceeded more than once per year

Number of Parameters Monitored

According to the Network Assessment Guidance, "air monitoring sites hosting monitors collocated with other measurements are likely more valuable than sites where fewer parameters are measured." This analysis addresses two aspects of site value. First, collocated measurements of several pollutants are valuable for many air quality analyses, such as source apportionment, model evaluation, and emission inventory reconciliation. Second, a single site with multiple measurements is more cost-effective to operate than monitors located at several sites. Sites were analyzed by the number of parameters (or instruments) collected. Sites at which many parameters are measured are ranked highest.

Measured Concentrations

The objective of the measured concentration analysis is to identify individual monitors by pollutant that sample the highest concentrations for that pollutant. Design values for each monitor were calculated utilizing air monitoring data from 2015 through 2019. Per the Network Assessment Guidance, "[m]onitors that measure high concentrations or design values are ranked higher than monitors that measure low concentrations. … If more than one standard exists for a pollutant (e.g., annual and 24-hr average), monitors can be scored for each standard." For this analysis, the average concentrations used to determine the design value (DV_{ave}) for the assessment period (2015-2019) were used to determine

monitor rank. Highest ranked monitors exceed the NAAQS, sites within 10% less than the NAAQS are ranked as medium. These criteria are outlined below.

Monitor Rank	Criteria*
High	DV_{ave} > NAAQS
Medium	NAAQS ≥ DV_{ave} ≥ NAAQS – 10% * NAAQS
Low	DV_{ave} < NAAQS – 10% * NAAQS

* For pollutants with multiple NAAQS, the most stringent federal standard or the federal standard closest to exceedance was used in this analysis.

Deviation from NAAQS

The deviation from NAAQS analysis provides an indication of which sites were important for monitoring NAAQS compliance. Per the Network Assessment Guidance, "[s]ites measuring concentrations (design values) that are very close to the NAAQS exceedance threshold are ranked highest in this analysis. … Sites measuring concentrations well above or below the threshold do not provide as much information in terms of NAAQS compliance." For pollutants with multiple NAAQS averaging times, sites were ranked by each standard.

The design values for each pollutant were calculated and monitors were analyzed for each standard using the absolute value of the difference between the measured design value and the 2019 NAAQS. Monitors with the smallest absolute difference were deemed the most important in this test regardless of the design value being higher or lower than the standard following the criteria below.

Monitor Rank	Criteria*
High	|Deviation| < 10% of NAAQS
Medium	10% of NAAQS ≥ |Deviation| ≥ 20% of NAAQS
Low	|Deviation| > 20% of NAAQS

* For pollutants with multiple NAAQS, the most stringent federal standard was used in this analysis.

Trend Analyses

The trend analysis assesses the historical record of monitors located within the network. Monitors with a long historical record of data were more valuable to the network for tracking pollutant trends and control strategy effectiveness. In this analysis, monitoring sites within the District's network were analyzed based on the number of years of measurements specific to each pollutant. The ranking of monitors for this analysis follows the criteria below where the maximum number of years refers to the maximum number of years for all sites.

Monitor Rank	Criteria
High	Trend ≥ 75% of the maximum number of years
Medium	Trend is within 25% - 75% of the maximum number of years
Low	Trend < 25% of the maximum number of years

Exceedance Probability

As part of the ozone and $PM_{2.5}$ assessments, each monitoring site was evaluated using the NetAssess2020 v1.1 tool to determine if there was a less than 10% probability that the monitor would exceed 80% of the applicable NAAQS during the next three years based on concentrations, trends, and variability observed during the data period. This probability was only calculated by the NetAssess2020

v1.1 tool for ozone and $PM_{2.5}$. Exceedance probability was calculated by the tool by applying a bootstrap analysis to the concentration outputs of 2014-2016 source data from the EPA Downscaler Model.[22]

Monitor-to-Monitor Correlation

The monitor-to-monitor correlation technique determines the temporal correlation between monitors through a regression analysis. In other words, this analysis evaluates whether monitors statistically collect similar information and can be considered redundant to each other. Data from 2016 through 2018 for each monitor were compared with the NetAssess2020 v1.1 tool using the square of the Pearson correlation coefficient[23], R^2, to other monitoring sites within the network. Per the Network Assessment Guidance, "[m]onitor pairs with correlation coefficient values near one are highly correlated and should be ranked lower than those with correlation coefficient values near zero. Monitors that do not correlate well with other monitors exhibit unique temporal concentration variation relative to other monitors and are likely to be important for assessing local emissions, transport, and spatial coverage. Monitors with concentrations that correlate well (e.g., $R^2 > 0.75$) with concentrations at another monitor may be redundant."

Possible redundant sites would show fairly high correlations consistently across all of their pairings, however, due to the homogeneity of the terrain relative to the area of Sacramento County, two other factors were included in this analysis to determine redundancy in addition to Pearson correlations. As the Pearson correlation itself does not indicate if one site consistently measures pollutant concentrations at levels substantially higher or lower than the other, possible redundant sites would also have low average relative difference despite the distance. Therefore, the average relative difference and linear distance are calculated between sites and are indicators of the overall measurement similarity between the two sites. Site pairs with a lower average relative difference are more like each other than pairs with a larger difference, and in general, correlation between sites will decrease as distance increases.

In this analysis, the following three criteria were used as thresholds for possible redundancy and ranking of each monitor.

Monitor Rank	Criteria
High (meets 1 or less of the criteria)	Highest pairwise $R^2 > 0.75$
Medium (meets 2 of the criteria)	Distance between sites < 25% of the Maximum Distance between any two sites
Low (meets 3 of the criteria)	Mean Difference < 25% of the Maximum Mean Difference between any two sites

Area-Served Analysis

The purpose of the area-served analysis is to estimate the spatial coverage of each monitoring site to identify potential spatial gaps or redundancies in the network. Thiessen polygons were applied as a

[22] https://www.epa.gov/air-research/downscaler-model-predicting-daily-air-pollution

[23] EPA, Guidance for Data Quality Assessment, Practical Methods for Data Analysis. "The Pearson correlation coefficient measures a linear relationship between two variables. A linear association implies that as one variable increases so does the other linearly, or as one variable decreases the other increases linearly. Values of the correlation coefficient close to +1 (positive correlation) imply that as one variable increases so does the other…" https://www.epa.gov/sites/default/files/2015-06/documents/g9-final.pdf

standard technique to assign a zone of influence surrounding a given point (monitoring sites for this analysis). The polygons are a simple quantitative method to determine the areas closest to each monitoring site, of which the nearest site may be a monitor not operated by the District. Thiessen Polygons were generated using the NetAssess2020 v1.1 tool. Thiessen polygon boundaries in this assessment were limited to the boundaries of the jurisdiction of the District.

Thiessen polygons do not take into account terrain within the area of influence. Air quality measured by a monitor may not represent air quality at a location at a much higher elevation within the monitor's area of influence. However, there were no areas within Sacramento County excluded as being represented by a monitor due to complex terrain.

Using the Thiessen polygon technique, some monitors outside of District's network were found to be representative of a portion of Sacramento County. The District does not have control over the continued operation of these monitors, therefore regulatory monitors located outside of Sacramento County were not included as part of the assessment. Figure 5 presents an example of Thiessen polygons developed for the monitoring network by the NetAssess2020 v1.1 tool.

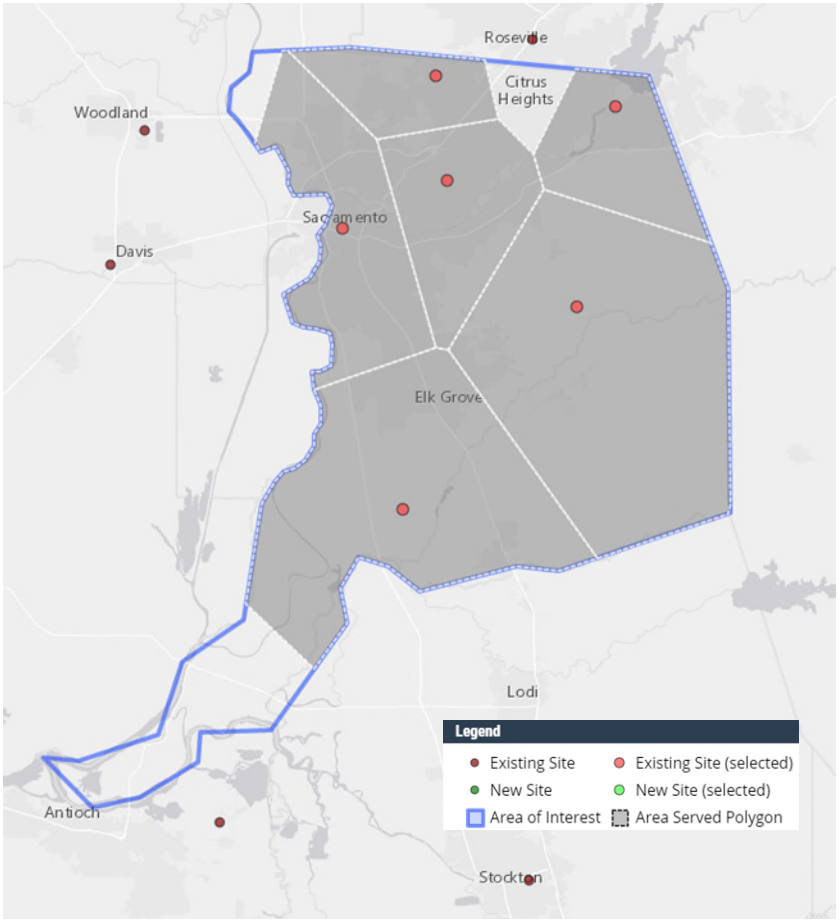


Figure 5 – Example of Thiessen polygons calculated by the EPA NetAssess2020 v1.1 tool for the area-served analysis.

Per the Network Assessment Guidance, "[s]ites are ranked based on their area of coverage. Sites that are used to represent a large area score high in this analysis." Therefore, for this analysis, the ranking

thresholds were set at 20% and 10% of the total county area. The approximate area of Sacramento County is 2574 km^2, therefore 20% and 10% of the total area equate to approximately 500 km^2 and 250 km^2, respectively. The ranking of monitors for this analysis follows the criteria below.

Monitor Rank	Criteria
High	Area-Served > 500 km^2
Medium	250 km^2 < Area-Served < 500 km^2
Low	Area-Served < 250 km^2

Population-Served Analysis

The purpose of the population-served analysis is to determine the population coverage represented by each monitoring site and to identify the sites surrounded by high population densities. Large populations can be associated with high emissions; therefore it is important in this analysis to investigate the impact of these possible emission sources on populated areas by assessing the number of persons served by each monitor. The population served by each site was calculated using the NetAssess2020 v1.1 tool where Thiessen polygons were created for each site (same polygons as the area-served analysis) and the population enclosed within that polygon was calculated from 2010 Census data.

Per the Network Assessment Guidance, "[s]ites are ranked based on the number of people they represent." In this analysis, a similar method to the Area-Served analysis was used with 20% and 10% thresholds. The total population of Sacramento County as of the 2020 US Census[24] was approximately 1.585 million persons. Therefore, 20% and 10% of the total population equate to approximately 317,000 and 159,000 persons, respectively. The ranking of monitors for this analysis follows the criteria below.

Monitor Rank	Criteria
High	Population-Served > 317,000 persons
Medium	159,000 persons < Population-Served < 317,000 persons
Low	Population-Served < 159,000 persons

Removal Bias

Removal bias sensitivity analysis determines monitor importance by the change in concentrations across the District monitors if a monitor is removed. The NetAssess2020 v1.1 tool was used to perform this analysis. Per the Network Assessment Guidance, "[g]reater bias or uncertainty indicates a more important site for developing interpolations to represent concentrations across a domain. Those sites with low bias may be providing redundant information." This analysis follows similar methodology to the Trends analysis where 75% and 25% thresholds were used for the maximum mean relative bias to determine monitor rank. The ranking of monitors for this analysis follows the criteria below where MRB is the mean relative bias.

Monitor Rank	Criteria
High	|MRB| ≥ 75% of the maximum MRB of all monitors
Medium	|MRB| is within 25% - 75% of the maximum MRB of all monitors
Low	|MRB| < 25% of the maximum MRB of all monitors

[24] United States Census Bureau: https://www.census.gov/quickfacts/fact/table/sacramentocountycalifornia/POP010220#POP010220.

Meteorology Network Assessment

Meteorological measurements are required based on the specifics of the air monitoring network associations, such as NCore, PAMS, and Near Road. The District meteorological network was assessed to determine if the network meets the requirements of 40 CFR Appendix D to Part 58, and if the network meets District monitoring objectives.

PAMS Network Assessment

The PAMS program originated to meet the requirements of Section 182(c)(1) of the Clean Air Act. The PAMS network was developed specifically to characterize upwind, new emissions, and downwind pollutant concentrations within a region for the purpose of understanding ozone precursor emissions, chemical transformation, geospatial ozone patterns, and transport. The objective of a PAMS network is to obtain measurements, which will assist air quality agencies to support ozone model development and track the trends of important ozone precursor concentrations.

A PAMS site typically monitors hydrocarbons and carbonyl compounds, ozone, oxides of nitrogen (NOx and/or NOy), and meteorological measurements. Lists of the specific pollutants and measurements required for the PAMS network and associated technical documents can be found on the EPA PAMS website[25]. The District has three active PAMS monitoring sites, which are included in Table 2.

In October 2015, the EPA Administrator signed the final rule for the NAAQS for ground-level ozone (80 FR 65291). As part of the new standard, EPA revised the PAMS network requirements and recommends five main areas of assessment. These areas are summarized as follows:

- Moving PAMS measurements to existing NCore sites.
- Preparing an Enhanced Monitoring Plan (EMP)[26] to be included in the annual monitoring network plan to improve monitoring of O_3, NOx/NOy, VOC, and meteorology.
- Using an automatic gas chromatograph (autoGC) for the determination of hourly averaged speciated VOCs.
- Enhancing meteorological stations to collect wind speed, wind direction, temperature, relative humidity, barometric pressure, precipitation, solar and ultraviolet radiation data.
- Measuring mixing height at the required PAMS monitoring site.

The approach of this assessment was to analyze the sites to ensure that the District met the PAMS requirements and that the District PAMS network also met the needs of the District and the intentions of the EPA network.

[25] EPA PAMS: https://www.epa.gov/amtic/photochemical-assessment-monitoring-stations-pams

[26] CARB is responsible for submitting the EMP for the entire state, including all Primary Quality Assurance Organizations (PQAO) and all air districts within the CARB PQAO that submit their own annual network plans and/or 5-year monitoring network assessments.

Data Uses Other Than Comparing to the NAAQS

As defined in 40 CFR Part 58 Appendix D, the network is designed to meet three basic monitoring objectives as discussed in the Network Objectives section of this document. The District monitoring network is designed to meet the first objective, provide air pollution data to the public in a timely manner through many different methods and programs. Some examples of where air pollution data can be accessed by the public include EPA's AirNow (https://www.airnow.gov/), CARB's Air Quality and Meteorological Information System (AQMIS; https://www.arb.ca.gov/aqmis2/aqmis2.php), and the District website (http://www.airquality.org/). More information on these and other non-regulatory uses of the data which directly inform the residents of Sacramento County of air quality conditions are discussed below.

Air Quality Forecasting

As the District is responsible for meeting state and federal health standards to improve the air quality for all residents of Sacramento County, a significant part of meeting these objectives is to provide the public with accurate forecasts and current conditions. The area's two biggest air pollutants are ground-level ozone and particulate matter. In Sacramento County, the majority of air pollution during the summer comes from mobile sources, which are cars, trucks, buses, agriculture, and construction equipment that are used every day. In the winter, the majority of air pollution comes from wood burning in residential fireplaces and wood stoves. As Sacramento County sits in a valley between the Coast and Sierra Nevada ranges, the topography is such that air pollution can at times be trapped at ground-level within the county. The addition of cars and trucks, high temperatures, no wind in the summer, residential wood burning in the winter, and wildfire smoke is a recipe for high ozone or particulate matter pollution. Therefore, air quality forecasting serves to both provide public information to inform residents so they can make healthy choices for themselves and their families as well as prevent unnecessary or harmful concentrations of air pollutants on days which are conducive to pollutant buildup.

Public Notification

The District has established a website (Spare The Air; www.sparetheair.com) in which the public has access to real-time and historical air quality and meteorological data. The District has also developed a Sacramento Region Air Quality mobile application which provides the daily forecast, current conditions, Spare The Air alerts, plus the daily burn status for Sacramento County from November through February. The Sacramento Regional Air Quality Index (AQI) and AQI forecast are available on the District's Spare The Air website, mobile application, and email air alerts as well as EPA's AirNow website. Historical air quality and meteorological data collected by the network can also be accessed by the public through EPA's AirData website (www.epa.gov/airdata). CARB also provides a portal to access District data through the CARB AQMIS website.

Air Quality Federal and State Planning

The second objective of the District ambient air monitoring network is to support compliance with ambient quality standards and emissions strategy development. This objective is met through the development of air quality plans such as State Implementation Plans (SIP). Air quality plans are

comprehensive strategies designed to meet or maintain compliance with federal and state air quality standards. The two most common types of plans are attainment plans and maintenance plans.

- Attainment plans show how the region will attain the air quality standard for a specific pollutant by a certain date, known as the attainment date.
- Maintenance plans are prepared after a region has attained an air quality standard and can demonstrate continued compliance with the standard.

Development of these plans requires extensive collaboration and cooperation with other agencies within the region, and includes businesses, industry, and the public. Included in the development of these plans are the use of meteorological and air quality models. These models are used to simulate air quality conditions, as compared to measured air quality data throughout the region. For the models to simulate air quality accurately, the models require a relatively dense monitoring network of pollutants and precursors for model validation.

Understanding background air pollutant concentrations is another vital component of plan development as background concentration measurements can improve the interpretation of the air monitoring data. For example, background concentrations can provide a point of reference for other measurements near emission sources. If the data collected near an emission source were elevated with respect to the determined background concentrations, the obvious initial assumption would be that the elevated concentrations sampled near the source are a result of emissions from that specific source. Another example could be using concentrations collected from a background site far from known emission point sources to provide evidence of regionally elevated concentrations such as wildfire smoke. Essentially, background concentrations will ideally indicate the measured pollutant concentrations that are equal to the concentrations measured at a location if local emission sources did not occur.

The District has submitted, or is in the process of developing, several planning efforts during the period of 2015 to the submission of this document, including the following:

- Submission of an Attainment Plan for the 2008 Ozone Standard in July 2017 which was approved by EPA on October 22, 2021 (effective November 22, 2021) (86 FR 58581)
- Submission of a Second 10-year PM_{10} Maintenance Plan which was approved by CARB and submitted to EPA in October 2021
- CARB submitted a Statewide (included Sacramento) Regional 8-Hour Ozone Milestone Compliance Demonstration Report to EPA in March 2021
- Submission of an PM_{10} Exceptional Event Demonstration for the 2018 Camp Fire to EPA in March 2021
- In development of an Attainment Plan for the 2015 Ozone Standard

Regional Air Quality Data and Trends

The third objective of the District ambient air monitoring network is to support air pollution research studies. Publicly available air pollution data collected by the District can be used to supplement data collected by researchers working on various aspects of the air quality field. Some examples of these projects are health effects assessments and atmospheric processes, or for monitoring methods development work. As discussed throughout this assessment, the District provides air quality data for many pollutants, many of which are required for attainment purposes. However, the District also

samples many other pollutants which are vital to air pollution research studies. Examples would be speciated particulate matter, VOCs, black carbon, and meteorological parameters. Other data the District provides and maintains which could be vital to research studies are included in the various community-focused programs as outlined in the Additional Enhanced Air Monitoring Efforts section of this assessment.

There are two pollutants of most concern in Sacramento County – particulate matter and ozone. The trends in concentrations of both pollutants are improving from a public health aspect. These trends are discussed in more detail within the respective pollutant sections of this assessment below. This trend is also consistent for regional concentrations, where regional is defined as the respective nonattainment areas as shown in Figure 3.

The following sections provide overviews of how the air monitoring data collected by the District network is able to support air quality programs at the District, which in turn have direct impacts on pollutant trends. This highlights the strong link between the monitoring network and the successes in reducing pollutant concentrations in Sacramento County and ultimately improvements to quality of life for Sacramento residents.

Ozone Concentrations

Ozone concentrations peak in the summer when there are calm winds, high temperatures, and maximum insolation, conditions necessary for the photochemical production of ozone from ozone precursors. In Sacramento, ozone precursor emission trends show significant declines in emissions, despite increasing population, vehicle activity, and economic development[27]. The eastern portion of the SFNA consistently measures the highest 8-hr ozone concentrations in the SFNA due to meteorology, topography, and photochemical processes. The 8-hr ozone NAAQS is described in detail in the ozone section of this assessment. There is year-to-year variability in the site within the SFNA which measures the maximum concentration. This is due in part to meteorological variability, wildfire impacts, and changes in precursor emissions. Figure 6 shows the peak 8-hour ozone design value concentrations for the SFNA during the period 1990-2019, excluding outlier concentrations in 2016 and 2018 which were suspected to be impacted by wildfire smoke. The drop in ozone design value concentrations corresponds to a dedicated decrease in ozone precursors, despite increases in temperature and other meteorological variables as a result of climate change. Further details on the impacts of climate change on global temperatures is discussed in the Natural Event Impacts on the Monitoring Network section.

Detailed in the Sacramento Regional 2008 NAAQS 8-Hour Ozone Attainment and Reasonable Further Progress Plan[28], the SFNA air districts are implementing existing regional and local control measures (including stationary source measures), and are assisting the Sacramento Area Council of Governments (SACOG) in implementing existing transportation control measures. The agencies track the implementation of the control measures and monitor the success of the measures and transportation

[27] CEPAM: 2016 SIP Baseline Emission Projections, Section a1 – Emission Projections With External Adjustments, Sacramento NAA 2016 Ozone SIP Version 1.04.

[28] Sacramento Metropolitan Air Quality Management District, Sacramento Regional 2008 NAAQS 8-Hour Ozone Attainment and Reasonable Further Progress Plan, 24 July 2017. Print.

control measures committed to in the 1994 SIP[29] and 2013 SIP[30]. CARB also tracks the implementation and success of mobile sources emissions control programs.

Since 1990, the SFNA shows a declining trend in exceedances of the 2008 8-hour ozone NAAQS and ozone design value concentrations, with the most frequent and highest violations occurring at the easternmost monitoring sites. VOC and NOx emissions inventory forecasts show significant declines in mobile source emissions, despite increasing population, vehicle activity, and economic development in the Sacramento region. Photochemical modeling results also show declines in ozone concentrations due to combined reductions from existing local strategies, regional, state, and federal control measures.

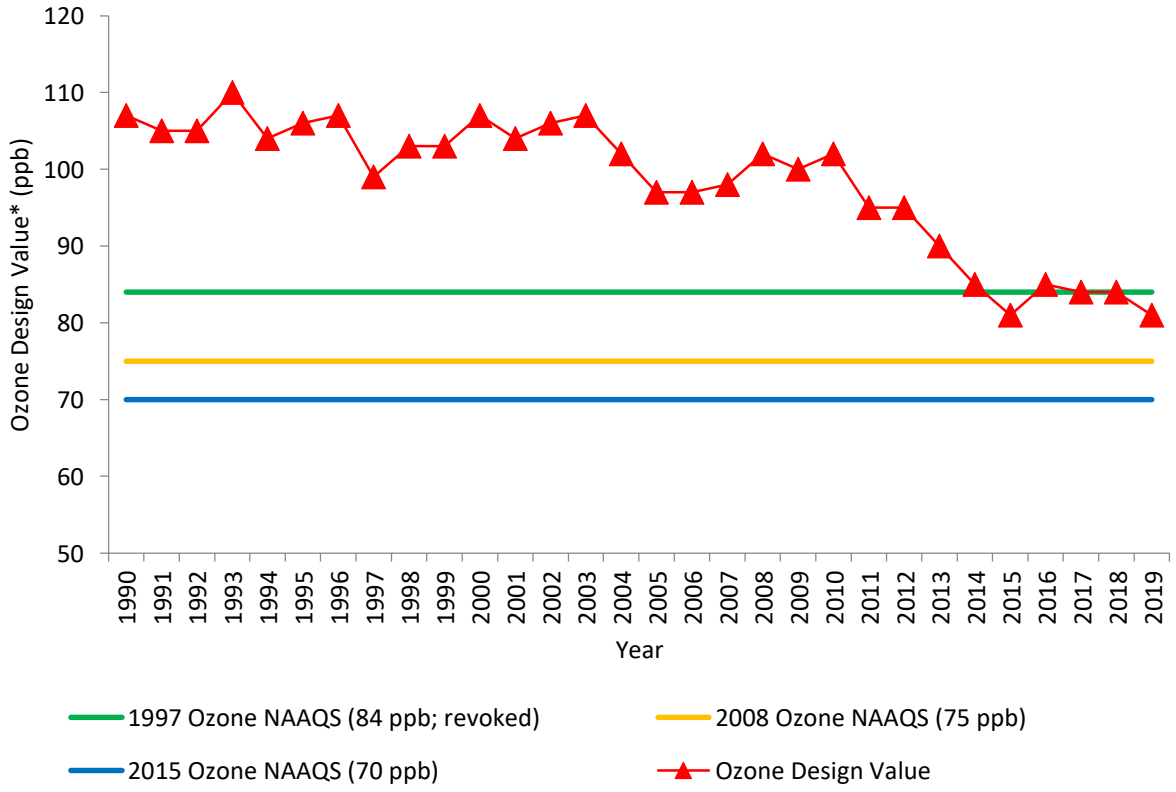


Figure 6 – 8-hour ozone design values for the Sacramento Federal Ozone Nonattainment Area for 1990-2019 (source: EPA AQS).

Source: EPA AQS (https://www.epa.gov/aqs).
*Design value is calculated as the annual fourth-highest daily maximum 8-hour ozone concentration averaged over three years.
Note: The SFNA was impacted by wildfires in 2018 which caused exceptionally high ozone concentrations. The peak design value calculation in this chart excluded suspected days impacted by wildfires.

[29] Sacramento Metropolitan Air Quality Management District, Sacramento Area Regional Ozone Attainment Plan, 15 November 1994. Print.
[30] Sacramento Metropolitan Air Quality Management District, Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan (2013 SIP Revision), 26 September 2013. Print.

Fine Particulate Matter ($PM_{2.5}$) Concentrations

Fine particulate matter can be emitted directly into the atmosphere or formed through chemical reactions of precursors such as NOx, sulfur dioxide (SO_2), VOCs, and ammonia (NH_3). Precursor emissions have decreased since 2005 and based on projections are expected to continue to decrease in the future despite an increase in population and economic growth[31]. The $PM_{2.5}$ design values are described in detail in the $PM_{2.5}$ section of this assessment. Figure 7 shows $PM_{2.5}$ design value concentrations from 2000 to 2019 and similar to ozone above, excludes exceptionally high concentrations due to wildfires in 2018.

The majority of directly emitted $PM_{2.5}$ in the nonattainment area is the result of fuel combustion, including wood burning. The District and the local air districts of the nonattainment area, have rules to control directly emitted $PM_{2.5}$ and $PM_{2.5}$ precursors. The District has made significant progress in reducing ambient $PM_{2.5}$ concentrations since 2007, after implementation of a wood burning regulation, Rule 421 Mandatory Episodic Curtailment Of Wood And Other Solid Fuel Burning[32], which restricts or prohibits the use of all fireplaces, woodstoves, inserts and pellet stoves when $PM_{2.5}$ concentrations are forecast to be high. Excluding wildfire events, exceedances of the standard most often occur in Sacramento County during the winter months when residential wood burning and mobile source emissions are the most important sources. Concentrations have remained relatively unchanged since 2012.

[31] CEPAM: NORCAL 2012 $PM_{2.5}$ SIP Baseline Emission Projections, Section a1 – Emission Projections With External Adjustments, Sacramento Nonattainment Area 2012 $PM_{2.5}$ SIP Version 1.01.
[32] Sacramento Metropolitan Air Quality Management District: http://www.airquality.org/ProgramCoordination/Documents/rule421.pdf.

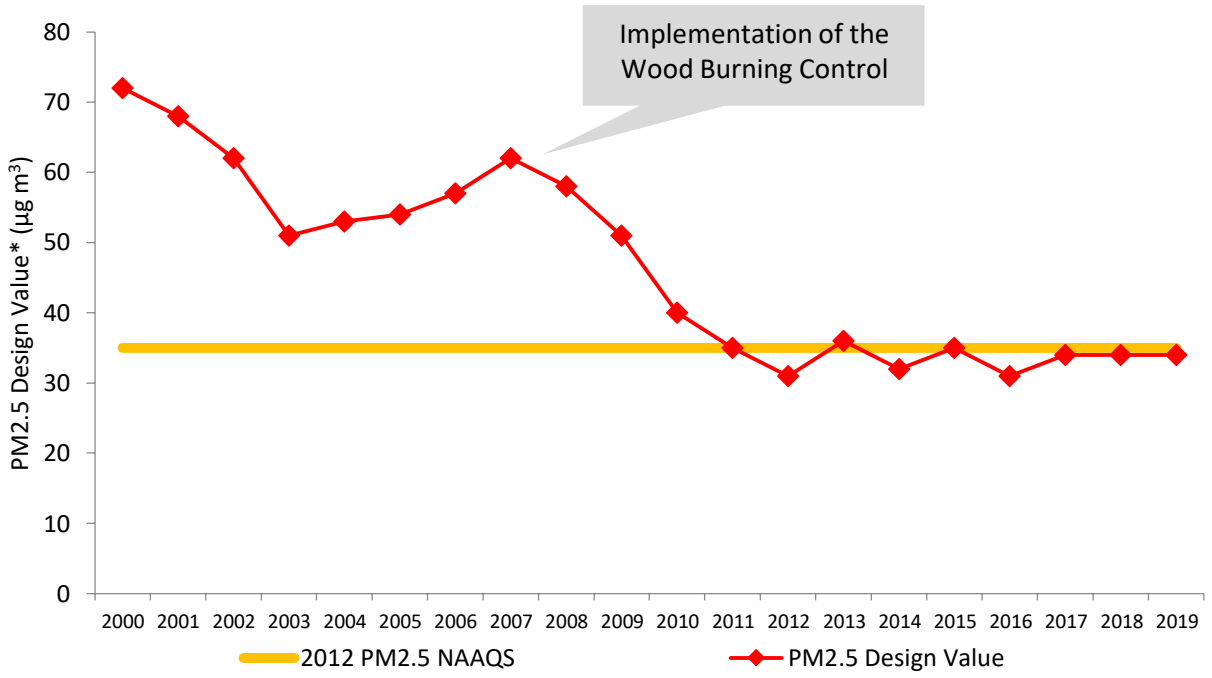


Figure 7 – 24-hour $PM_{2.5}$ design values for the Sacramento Federal $PM_{2.5}$ Area Designation for 2000-2019 and the approximate implementation of wood burning controls in the form of Rule 421 (source: EPA AQS, District).

*Design value is calculated as the 98th percentile concentrations, averaged over 3 years.
Note: The SFNA was impacted by wildfires in 2018 which caused exceptionally high $PM_{2.5}$ concentrations. The peak design value calculation in this chart excluded suspected days impacted by wildfires.

Natural Event Impacts on the Monitoring Network

Natural events can have drastic impacts on air quality in very short periods of time, therefore ambient air monitoring networks need to be prepared as best as possible for these situations. This section details natural events that specifically impact the District network. The impacts of these events are incorporated throughout the assessment on a pollutant-specific basis. The natural events in this section are unusual or naturally occurring events that are not reasonably controlled by air quality agencies. In general, this means that the techniques that agencies implement to control air quality to maintain the NAAQS are ineffective or limited during these events. General examples of natural events include wildfires, high wind dust, prescribed fires, stratospheric ozone intrusions, and volcanic and seismic activities. EPA provides a mechanism for determining if air quality monitoring data has been influenced by one of these natural events. This is outlined in the Treatment of Data Influenced by Exceptional Events (81 FR 68216). This rule provides criteria and procedures for excluding a natural event impacted data from regulatory decisions, such as attainment status. However, as mentioned above, at the time of an event it is important that air monitoring networks are robust enough to provide timely air quality data to the public and collect enough data for subsequent research into the event. In Sacramento County, the most common natural events which impact the District air monitoring network are wildfires and high wind dust events.

Wildfire Impacts

Table 5 shows the total number of fires in California from 2015-2019 and the total number of acres burned. Due to the topography and climate of California, months of active burning continuously emitted smoke from wildfires located in the heavily forested mountainous regions which settled in the valleys, including the Sacramento metropolitan area. As shown in Figure 8, the normal meteorological conditions in the Sacramento region are conducive to wildfire activity, that is warm temperatures and low precipitation totals during the summer months. Figure 9 shows Sacramento County's location in reference to the topography of California as well as the area burned by wildfires during the assessment period from 2015-2019. Sacramento lies within a long northwest-southeast valley between the Sierra Nevada Mountains and the Coastal Mountains, a region that fills with smoke during periods of heavy wildfire activity.

Table 5 – Total number of wildfires, total acres burned, and selected major fire names from 2015-2019 (source: CalFire).

Year	Number of Fires	Total Acres Burned	Select Major Fire Names
2015	8,283	880,899	
2016	6,954	669,534	
2017	9,270	1,548,429	Thomas
2018	7,948	1,975,086	Camp Fire, Carr Fire, Mendocino Complex
2019	7,148	277,285	

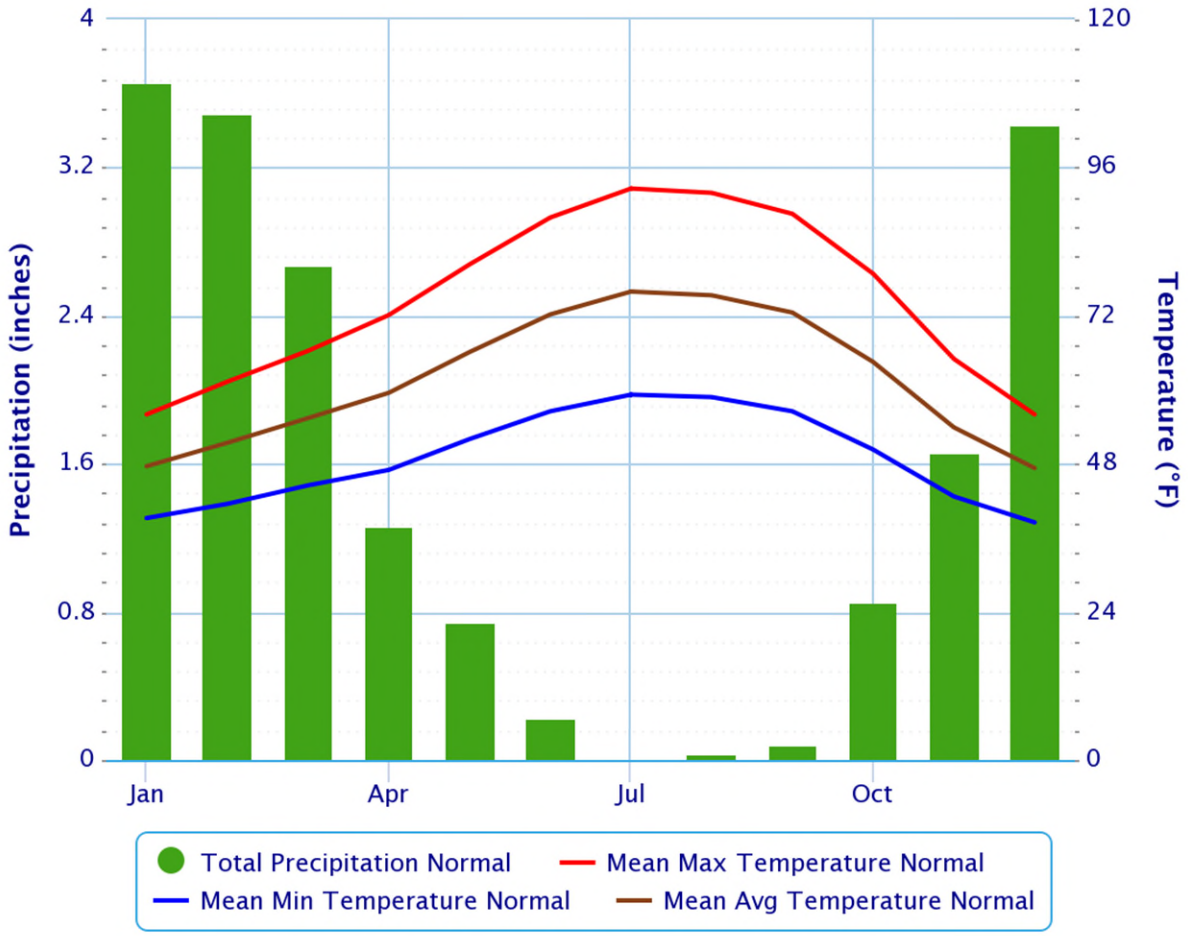


Figure 8 – Monthly climate normal for the Sacramento area for the period 1991-2020 (source: NOAA NWS[33]).

[33] National Oceanic and Atmospheric Administration, National Weather Service, NOWData climate data for Sacramento, CA; https://www.weather.gov/wrh/climate?wfo=sto.

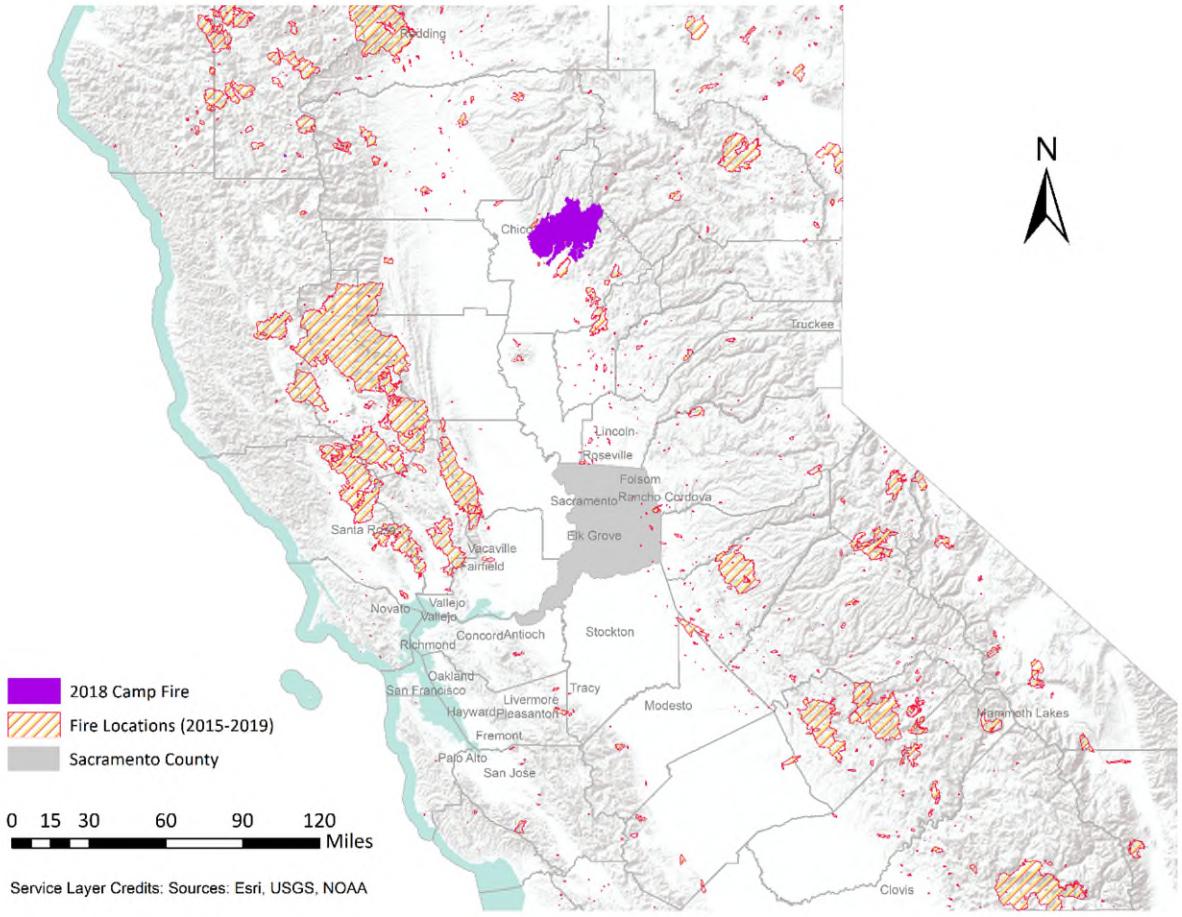


Figure 9 – Perimeters of Sacramento County and wildfires for the period 2015-2019. The Camp Fire wildfire from 2018 which directly impacted air quality in Sacramento County is highlighted in purple (Source: CalFire; California Department of Technology).

The Camp Fire wildfire of 2018 was a particularly impactful and deadly wildfire. The perimeter of the Camp Fire is shown in Figure 9. This fire remains the deadliest fire in California history with 85 deaths and over 85,000 structures destroyed at time of publication[34]. In November of 2018, the Camp Fire entered the town of Paradise in Butte County and emitted an extensive plume of heavy smoke that blanketed Sacramento County. The plume was clearly visible in satellite imagery as shown in Figure 10. CARB has prepared an extensive summary of the air quality impacts from the Camp Fire throughout California[35]. The impacts on the District network due to the Camp Fire and the associated data handling are addressed in the specific pollutant sections within this assessment.

[34] California Department of Forestry and Fire Protection (CAL FIRE), Top 20 Deadliest California Wildfires; https://www.fire.ca.gov/media/lbfd0m2f/top20_deadliest.pdf. Data valid October 2021.
[35] California Air Resources Board, Camp Fire Air Quality Data Analysis: https://ww2.arb.ca.gov/sites/default/files/2021-07/Camp_Fire_report_July2021.pdf.

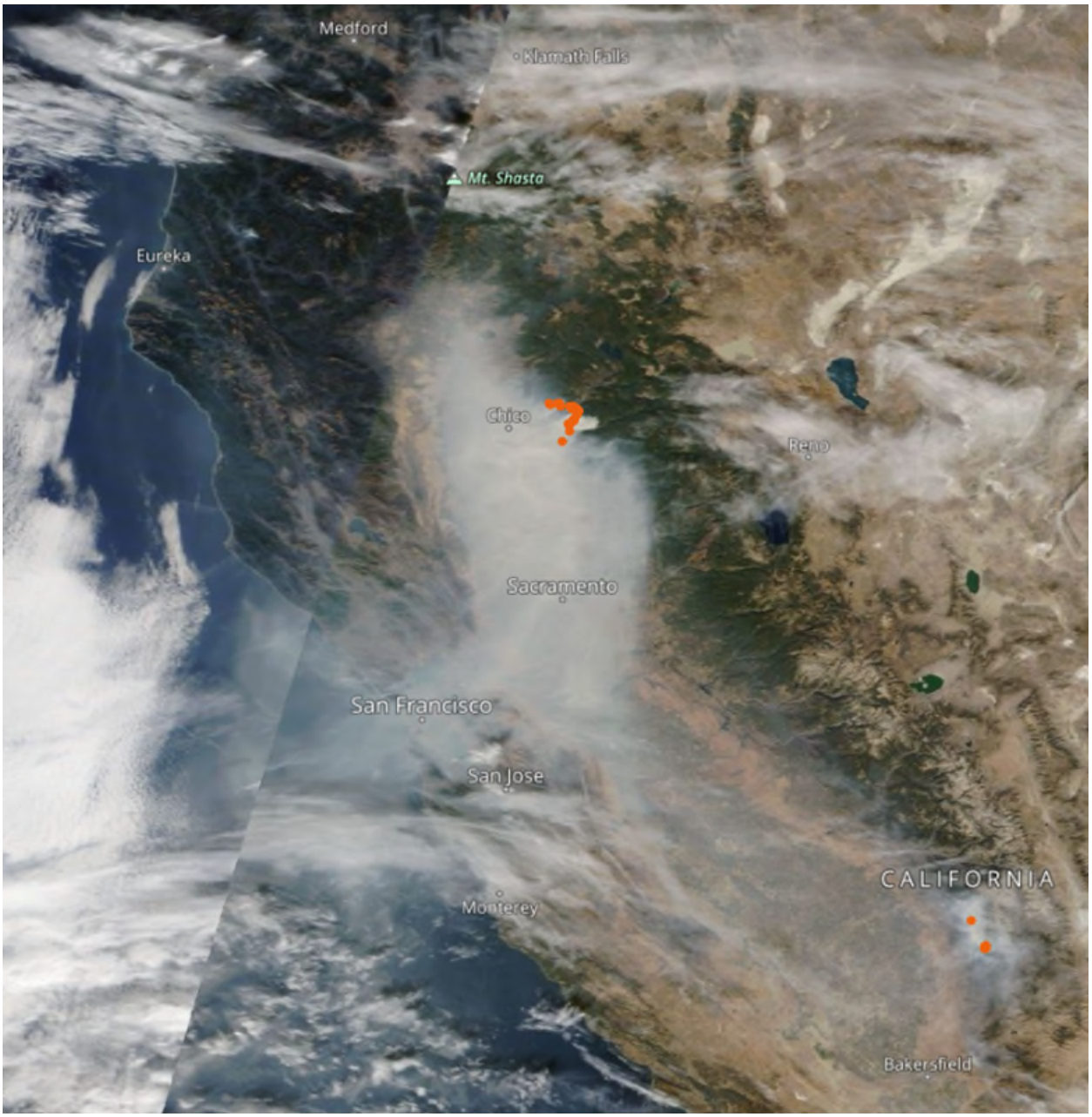


Figure 10 – Heavy smoke throughout the Sacramento and San Joaquin Valleys of California during the Camp Fire wildfire as seen from the MODIS satellite on November 15, 2018 (source: NASA; https://worldview.earthdata.nasa.gov/). Red dots indicate satellite derived hotspots, the northernmost cluster represents the Camp Fire wildfire.

Effects of Climate Change on Wildfires

Climate change is a critical part of the District's vision of clean air and a low-carbon future for all. The District provides outreach and education, data analysis and research, and support for local, regional, state, and federal initiatives to address climate change. Part of these efforts include assessing and adapting the District air monitoring network to a changing climate. An increasingly prevalent burden on Sacramento County residents and the District network is from wildfires. The multi-pollutant impact of these wildfires highlights the importance of understanding the nature and constitution of climate change enhanced wildfires and applying that knowledge throughout the assessment of the District network.

Climate change due mainly to the burning of fossil fuels has caused an increase in the frequency and severity of wildfires throughout California[36]. Global warming trends are unequivocally the result of human activity.[37] These trends have led to unusually warm temperatures throughout California. These trends can be seen in Figure 11 where the average air temperature in the western United States from 2000 to 2020 has increased dramatically from the long-term average (1895–2020)[38].

The warming temperatures in the western United States have intensified the effects of drought conditions, or years with below-average water supply. Drought conditions are natural within climate cycles, however as the Earth's atmosphere warms, drought conditions are becoming more frequent, severe, and pervasive. Figure 12 shows the percentage of Sacramento County by area that is within United States drought monitor categories for the period 2000-2022[39]. Throughout the last decade, including the assessment period, Sacramento County has experienced periods of Exceptional Drought conditions (D4). Possible impacts of D4 conditions are exceptional and widespread crop/pasture losses and shortages of water in reservoirs, streams, and wells creating water emergencies. Increasingly warmer temperatures combined with very low precipitation and snowpack create conditions for extreme, high severity wildfires that can spread rapidly throughout the state.

[36] California Air Resources Board, Wildfires & Climate Change. https://ww2.arb.ca.gov/wildfires-climate-change

[37] IPCC Sixth Assessment Report, Summary for Policymakers. https://www.ipcc.ch/report/ar6/wg1/#SPM
B.D. Santer et.al., "A search for human influences on the thermal structure of the atmosphere," Nature 382 (4 July 1996), 39-46
Gabriele C. Hegerl, "Detecting Greenhouse-Gas-Induced Climate Change with an Optimal Fingerprint Method," Journal of Climate, v. 9 (October 1996), 2281-2306
V. Ramaswamy et.al., "Anthropogenic and Natural Influences in the Evolution of Lower Stratospheric Cooling," Science 311 (24 February 2006), 1138-1141
B.D. Santer et.al., "Contributions of Anthropogenic and Natural Forcing to Recent Tropopause Height Changes," Science vol. 301 (25 July 2003), 479-483.
T. Westerhold et. al., "An astronomically dated record of Earth's climate and its predictability over the last 66 million years," Science vol. 369 (11 Sept. 2020), 1383-1387.

[38] EPA Climate Change Indicators, Weather and Climate. https://www.epa.gov/climate-indicators/southwest

[39] U.S. Drought Monitor, a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. https://droughtmonitor.unl.edu/. Data valid January 2022

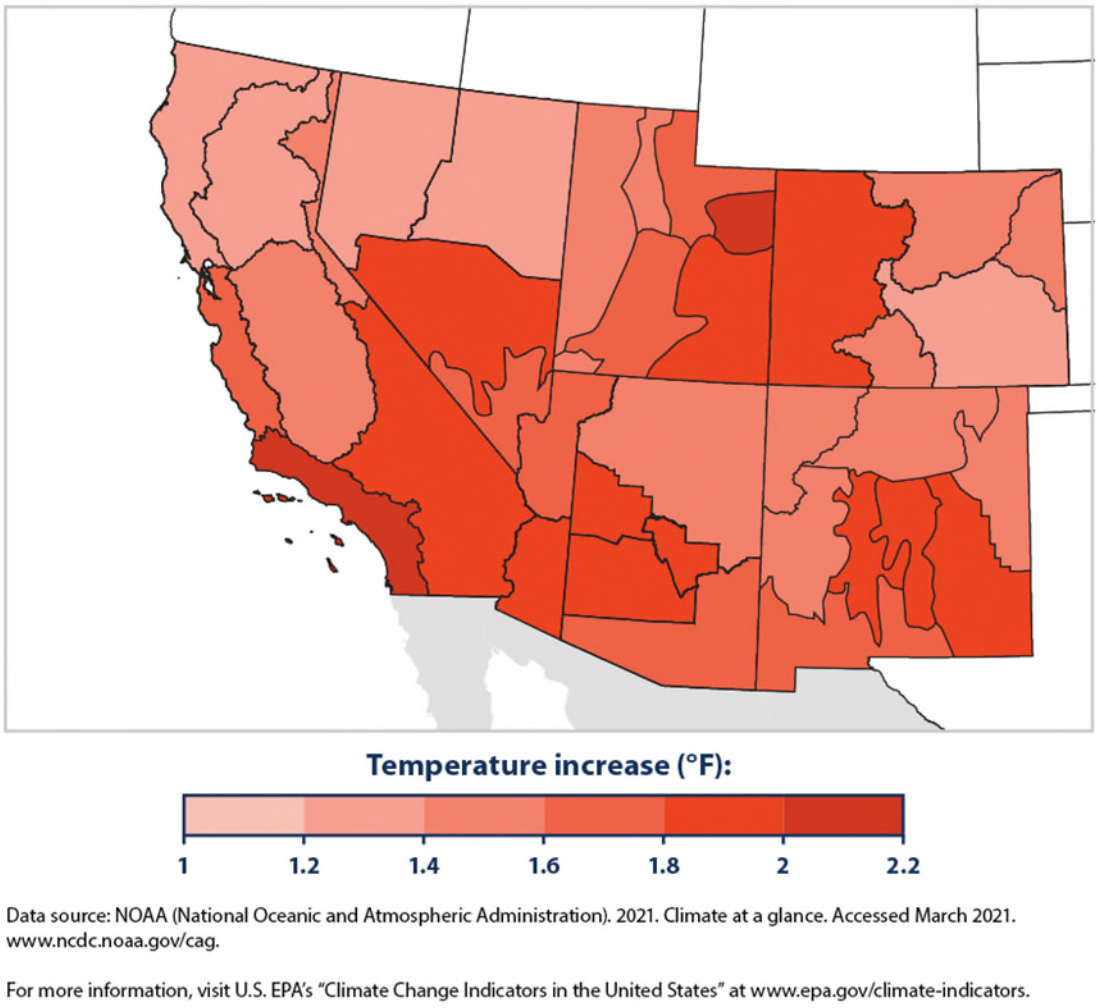


Figure 11 – Average temperatures in the southwestern United States, 2000-2020 versus the long-term average from 1895-2020 (source: EPA).

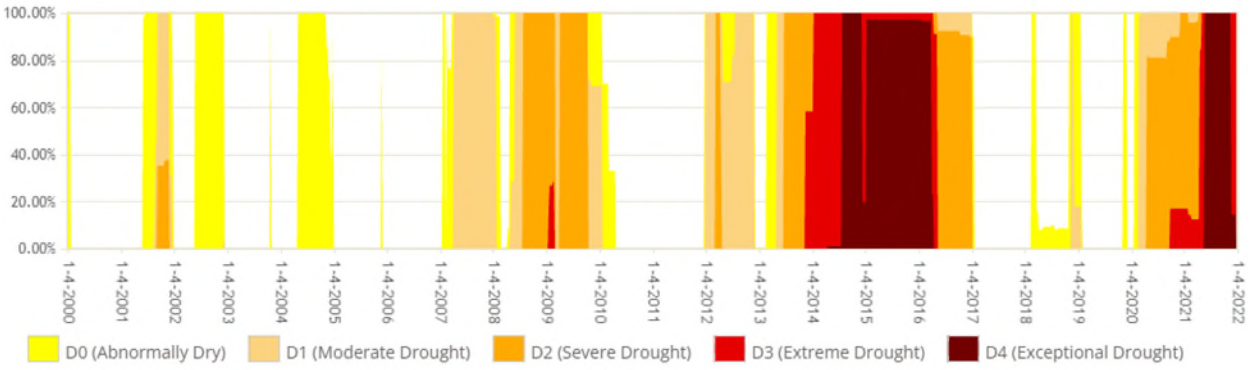


Figure 12 – Timeseries of the percentage of Sacramento County by area within U.S. drought monitor categories (source: National Drought Mitigation Center)

Proof of this climate change enhanced increase in wildfire activity throughout the western United States is shown in the change in annual burned acreage between 1984-2001 and 2000-2018[40] (source: EPA, Figure 13). The extent of burned land in California increased by 2.46 acres per square mile of land area in 1984-2001 as compared to 2000-2018. This is the fourth highest value in the United States behind only Idaho, Washington, and Oregon, all of which can also have smoke impacts on California.

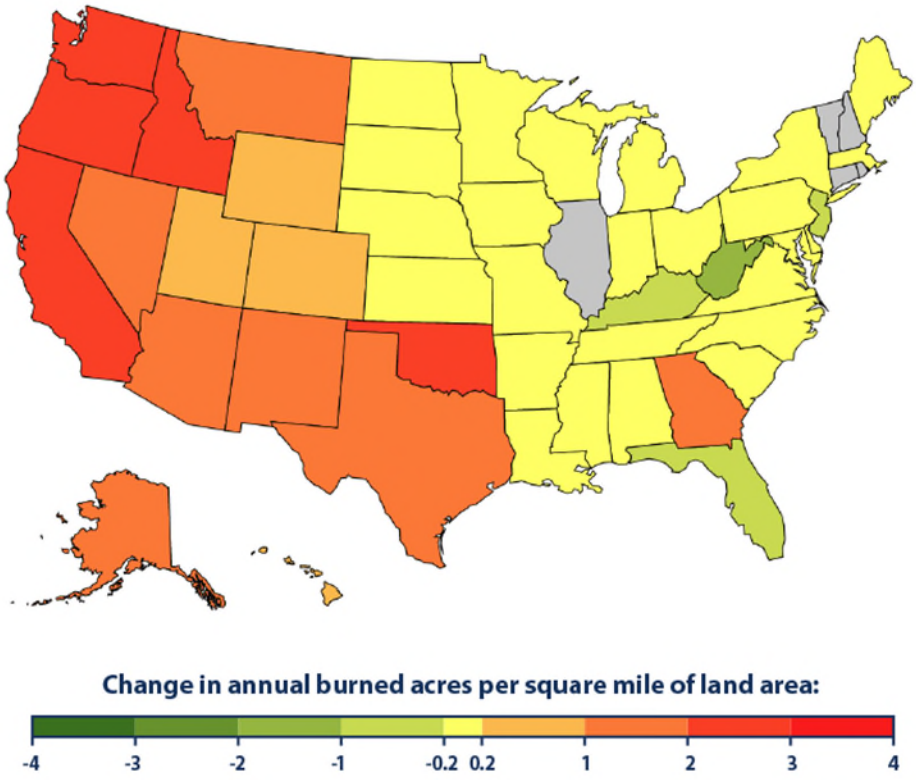


Figure 13 – Change in annual burned acreage by state between 1984-2001 and 2000-2018 (source: EPA).

Within California specifically, a time series of the total annual burned acreage due to wildfires shows the increase in wildfire activity throughout the last decade[40] (source: EPA, Figure 14).

[40] EPA Climate Change Indicators: Wildfires. https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires

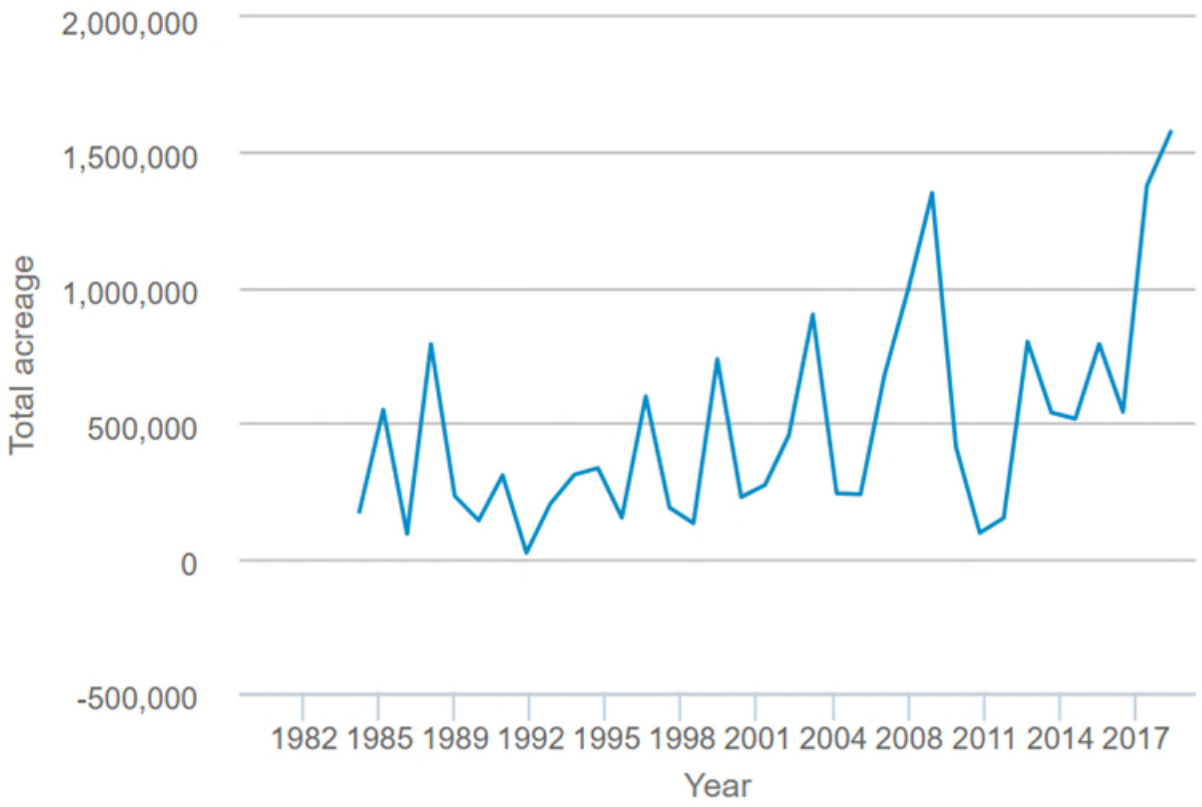


Figure 14 – Total annual burned acreage due to wildfires (source: EPA).

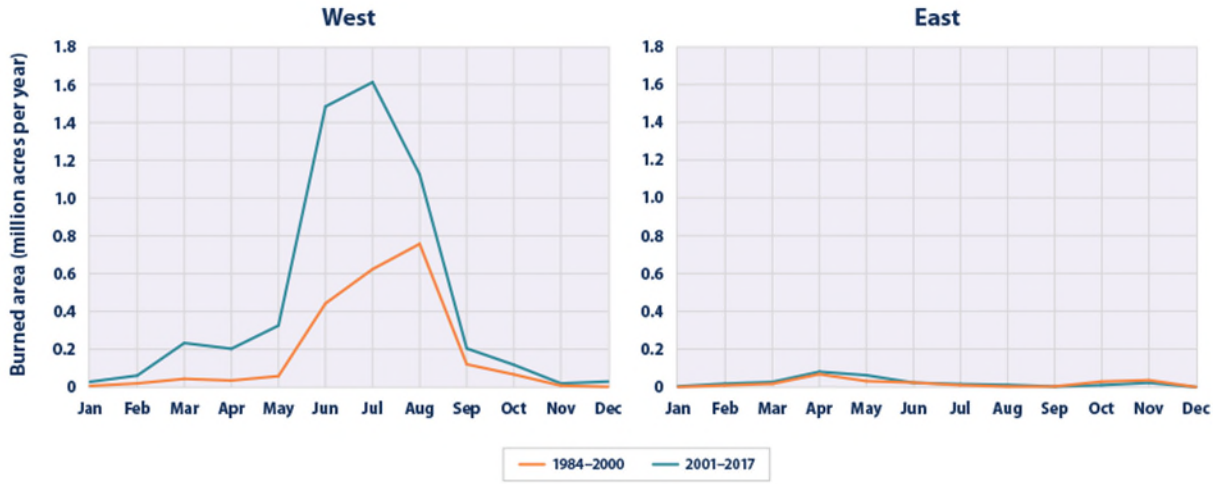
As Figure 13 and Figure 14 highlight, the frequency of total fire activity has increased in the last decade throughout the western United States. However, not to be lost in this is that the severity and magnitude of individual major wildfires during just the last five years in California has been catastrophic. At the time of publication, fires from 2018, 2020, and 2021 combined to burn more than 3.5 million acres and make up the six largest wildfires in California history[41] (source: CalFire, Table 6). At this time, there is no data to indicate that this trend will reverse.

[41] California Department of Forestry and Fire Protection (CalFire), Top 20 Largest California Wildfires. https://www.fire.ca.gov/media/4jandlhh/top20_acres.pdf. Data valid October 2021.

Table 6 – Top 6 largest wildfires by acreage in California history (source: CalFire).

	Fire Name	Date	County	Acres	Structures	Deaths
1	August Complex	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, & Colusa	1,032,648	935	1
2	Dixie	July 2021	Butte, Plumas, Lassen, Shasta & Tehama	963,309	1,329	1
3	Mendocino Complex	July 2018	Colusa, Lake, Mendocino & Glenn	459,123	280	1
4	SCU Lightning Complex	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, & San Joaquin	396,624	222	0
5	Creek	September 2020	Fresno & Madera	379,895	853	0
6	LNU Lightning Complex	August 2020	Napa, Solano, Sonoma, Yolo, Lake, & Colusa	363,220	1,491	6

Wildfire data also indicates that wildfire activity has increased recently in the shoulder seasons historically not conducive to wildfire conditions[40]. Figure 15 shows that the total burned acreage in the western United States has increased noticeably in nearly every month of the year (source: EPA). This is yet another factor that ultimately increases the frequency of elevated ground-level pollutant concentrations from wildfires and directly impacts public health.



Data source: MTBS (Monitoring Trends in Burn Severity). 2019. Direct download. Accessed November 2019. www.mtbs.gov/direct-download.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Figure 15 – Comparison of monthly burned area due to wildfires in the Eastern and Western United States between 1984–2000 and 2001–2017 (source: EPA).

Increases in the severity and frequency of wildfires as a result of climate change have significantly elevated air pollutant concentrations throughout much of California. As shown in Figure 9, Sacramento County lies in a large valley extending throughout the interior of California. During large wildfire events located anywhere from the city of Bakersfield north to Washington State and beyond, depending on wind direction, smoke can commonly be transported throughout the entire interior of California, thus increasing pollutant concentrations in Sacramento County. These pollutants can include fine particulate matter, ozone, carbon monoxide, and others, and can have drastic impacts on public health. Without meaningful mitigation to these changes in climate, dangerous smoke impacts will become more frequent and the new normal within Sacramento County. The wildfire impacts on pollutant concentrations are factored into this assessment and addressed specific to each pollutant in the appropriate sections.

High Wind Dust Impacts

In Sacramento County, high wind dust events can occur when high-speed wind entrains and transports dust. These events can cause drastic and at times sudden increases in particulate matter concentrations. It is possible for these events to impact Sacramento County due to the proximity of the county to agricultural activities as well as frequent construction sites throughout the county. Figure 16 shows the large amount of agricultural land surrounding Sacramento County[42] (source: CNRA). Similar to the effect climate change has on wildfire impacts, warmer and drier atmospheric conditions can lead to increased high wind dust events. Consistent with Figure 12, extreme drought conditions can cause fields to be extremely dry or left fallow exposing dry, loose soil for wind to entrain. The high wind dust impacts on pollutant concentrations are factored into this assessment and addressed specific to each pollutant in the appropriate sections.

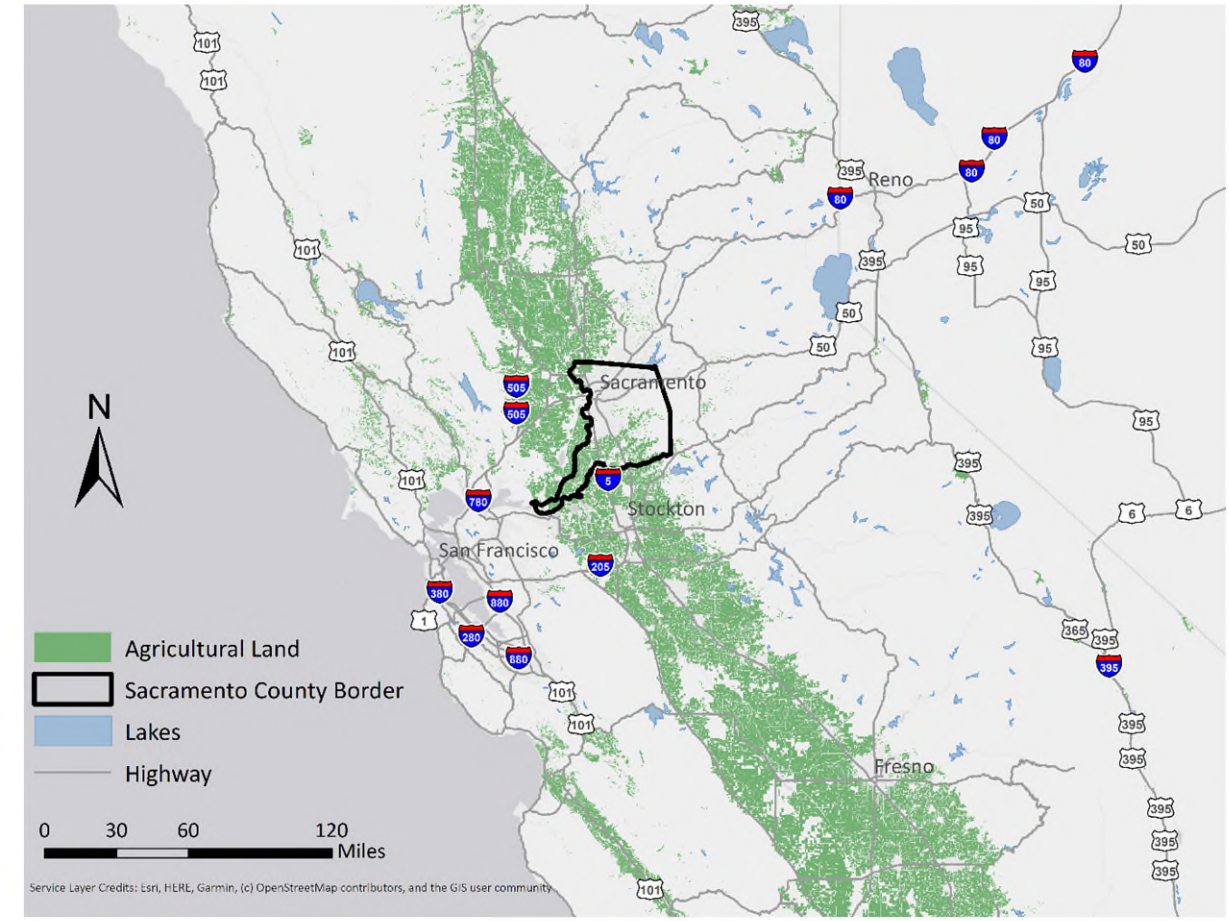


Figure 16 – Map of agricultural land and Sacramento County (source: CNRA)

[42] California Natural Resources Agency, California Department of Water Resources, Land IQ. 2018 Statewide Crop Mapping. https://data.cnra.ca.gov/dataset/statewide-crop-mapping.

Network-Wide Analyses (Pollutant Non-specific)

An evaluation of the District's ambient air monitoring network was evaluated by the number parameters (O_3, $PM_{2.5}$, PM_{10}, NO_2, CO, SO_2, Pb, meteorological, and PAMS measurements). Each section below provides explanations pertaining to monitoring objectives and spatial scales as well as recommendations based on the analyses outlined above. As mentioned in the Technical Approach section, the number of parameters monitored analysis is performed on the network as a whole, whereas each of the other analyses are applied and concluded upon a pollutant-specific basis.

Number of Parameters Monitored Analysis

There are a total of eight (8) ambient air monitoring sites located within Sacramento County. Each station is categorized as SLAMS, PAMS, CSN, NCore, and/or SPM. Table 7 lists the number of parameters, categorized by pollutant type and meteorology, measured at each site within the District network. The total number of parameters sampled are summed for each station. The total score is shaded red, with the highest overall score darkest. Sites at which many parameters are measured are ranked highest.

Table 7 – Number of parameters monitored at each District air monitoring station. The overall score is shaded red, with highest overall score darkest. Italicized is the discontinued North Highlands-Blackfoot station.

Parameter	BER	BC	BRU	DPM	FOL	*NH*	SLU	TST
O_3			1	1	1	*1*	1	1
$PM_{2.5}$	1		1	3	2		1	2
Speciated $PM_{2.5}$				1				1
PM_{10}		1		2		*1*		1
NO_2	1		1	1	1	*1*		1
CO	1			1		*1***		
SO_2				1				
Pb				1**				
NOy				1	1			
NMHC			1	1	1			
VOC*			1	1	1			
Carbonyl*				1				
$PM_{10\text{-}2.5}$				1				
BC	1			1				
Temperature	1		1	1	1			1
Wind Direction	1		1	1	1		1	1
Wind Speed	1		1	1	1		1	1
Relative Humidity			1	1	1			1
Barometric Pressure			1					
Precipitation			1					
Solar Radiation			1	1	1			
UV			1					
Mixing Height			1					
Total Score	**7**	**1**	**14**	**22**	**12**	***4***	**4**	**10**

* For this analysis, VOCs and carbonyls are each counted as one parameter instead of summing each specific species included in the laboratory analyzed VOC and carbonyl samples.
** monitor discontinued as approved by EPA via letter on April 20, 2020.

Monitoring sites collocating measurements of several pollutants are valuable for many air quality analyses, such as source apportionment, model evaluation, and emission inventory reconciliation. Also, a single site with multiple measurements is more cost-effective to operate than monitors located at several sites. Based on the number of parameters measured at each site, Sacramento-Del Paso Manor, Elk Grove-Bruceville, and Folsom-Natoma St. are the most important monitors within the network. Sacramento-Branch Center #2 is ranked lowest with a single parameter monitored. Monitoring of a single parameter at an air monitoring station is the least efficient and most cost-prohibitive situation possible. Therefore, the Sacramento-Branch Center #2 site will be evaluated for redundancy in the Coarse Particulate Matter (PM10) Network Analysis section.

Ozone (O_3) Network Analysis

Monitoring Objectives

Sacramento County has a total of five (5) active SLAMS ozone monitoring stations as shown in Figure 17. The North Highlands-Blackfoot station as discussed in the Recent Notable Modifications to the Network section was discontinued after the assessment period. Based on the characteristics of the sites, including the population served and the area served, each site can be designated as background, population oriented, or high concentration monitoring locations as listed in Table 8.

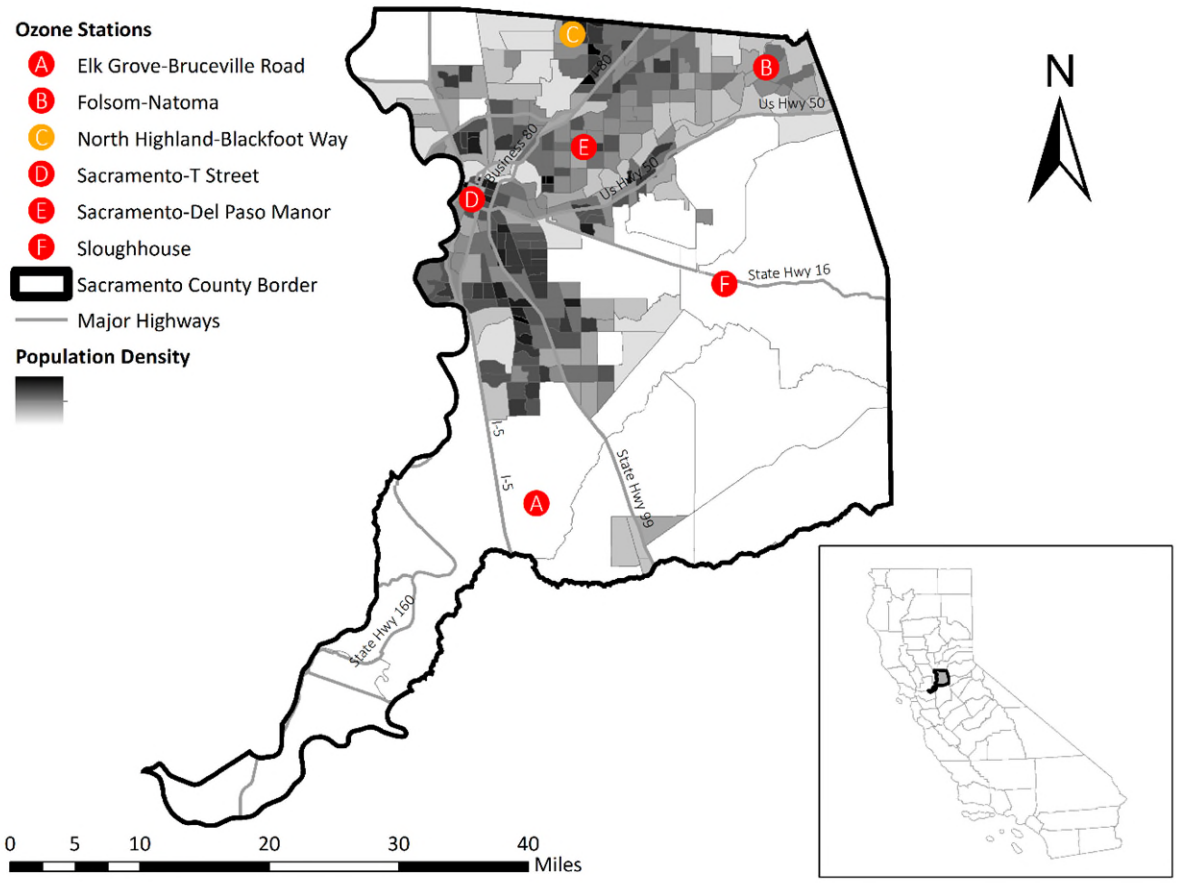


Figure 17 – Ozone network in Sacramento County. Darker shades indicate higher population density (source: 2010 US Census). Red markers indicate active monitors. Orange marker indicates an active monitor during the assessment period but is no longer an active monitor.

Table 8 – EPA network affiliation and monitoring objective for ozone monitors serving Sacramento County.

Site	EPA Network Affiliation*	Monitoring Type**
Elk Grove-Bruceville	PAMS	Background
Folsom-Natoma St.	PAMS	Population Oriented / High Concentration
North Highlands-Blackfoot	SPM	Population Oriented
Sacramento-1309 T Street		Population Oriented***
Sacramento-Del Paso Manor	NCORE	Population Oriented
Sloughhouse		High Concentration

Note: All monitors are SLAMS (State and Local Air Monitoring Stations) monitor type unless otherwise noted.
* NCORE (National Core Multi-pollutant Monitoring Stations), PAMS (Photochemical Assessment Monitoring Station), SPM (Special Purpose Monitor not part of SLAMS).
** Consistent with EPA monitoring types as listed in 40 CFR Part 58, Appendix D.
*** Sacramento-1309 T Street is officially classified as upwind/background for ozone, but for the purposes of this assessment, it is classified as population oriented due to the large number of people in the downtown core of Sacramento at any given time.

As discussed in the Background section, the District is part of a larger area, the Sacramento Federal Ozone Nonattainment Area (SFNA; Figure 18). The SFNA is designated by the EPA as a severe nonattainment area for the 1997 and 2008 8-hour O_3 standards, and serious for the 2015 8-hour O_3 standard (86 FR 59648). In addition to the District, the SFNA includes all or parts of four other regional air districts: El Dorado County Air Quality Management District, Feather River Air Quality Management District, Placer County Air Pollution Control District, and Yolo-Solano Air Quality Management District.

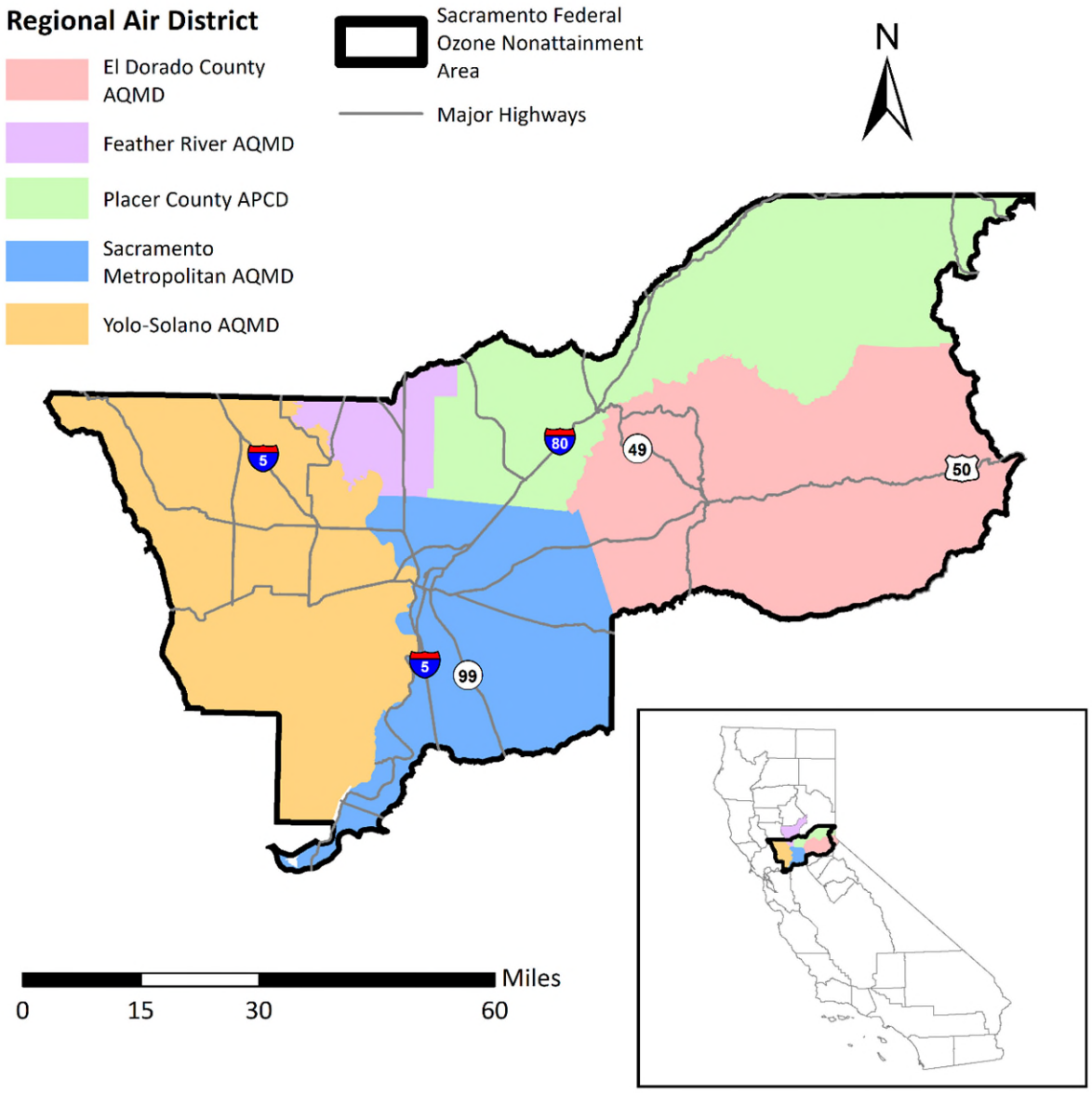


Figure 18 – Sacramento Federal Ozone Non-Attainment Area (SFNA).

In this assessment, the 2015 federal 8-hr ozone standard of 0.070 ppm will be used for comparisons. For 2015-2019, the number of daily maximum 8-hour exceedance days exceeding the 2015 Federal ozone standard (greater than 0.070 ppm) was calculated for each site and shown in Table 9. The exceedances were counted as number of station days that exceeded the 8-hour ozone standard, so multiple exceedances within a single day at a station were not counted.

Table 9 – Number of daily maximum 8-hour exceedance days exceeding the 2015 Federal standard (NAAQS; greater than 0.070 ppm) for 2015-2019. Totals include days which could potentially be considered exceptional under the Exceptional Events Rule.

Site	2015	2016	2017	2018	2019	Total
Elk Grove-Bruceville Road	2	1	3	2	4	12
Folsom-Natoma Street*	11	23	17	18	2	71
North Highlands-Blackfoot Way	8	16	8	10	2	44
Sacramento-Del Paso Manor	8	10	5	6	0	29
Sacramento-1309 T Street	4	3	3	1	1	12
Sloughhouse	14	17	6	4	1	42
Total	47	70	42	41	10	210
Total without Folsom	36	47	25	23	8	139

* Folsom-Natoma St. site was offline due to construction beginning late July 2019.

The background- and population-oriented only sites consistently had the least number of exceedance days. The sites that recorded two of the highest three frequencies of exceedances from 2015-2019 are the sites designated as high concentration sites, Folsom-Natoma St. and Sloughhouse, with a total of 71 and 42 exceedances, respectively. The other high frequency site is the North Highlands-Blackfoot Way site at 44 exceedances. The two high concentration sites are located downwind[43] of the urban core of the Sacramento metropolitan area as shown in Figure 1. This is consistent with the ozone formation process as ozone forms through photochemical reactions in the presence of precursor pollutants and sunlight. These photochemical reactions take time, and the air masses typically get transported away from emission sources before ozone forms. The total number of exceedances by year fluctuates, with 2019 being the lowest year in the previous 5 years. Note that the Folsom-Natoma St. site was offline due to construction beginning in late July 2019 throughout the rest of 2019 (covered 37% of the ozone season), which could introduce a low bias to the totals for 2019. A line with the Folsom-Natoma St. site data removed was added to the chart to highlight this possible bias. On average from 2015-2018, the Folsom-Natoma St. site contributed 35% of the ozone exceedances. If this average was projected for 2019, there would have been a total of 14 exceedances in 2019 as indicated with the orange point in Figure 19. The number of 8-hour exceedance days by year for each site in Sacramento County is broken down in Figure 20.

[43] Summertime wind direction in Sacramento County during days with the highest ozone concentrations is predominantly westerly, consistent with upslope terrain flow.

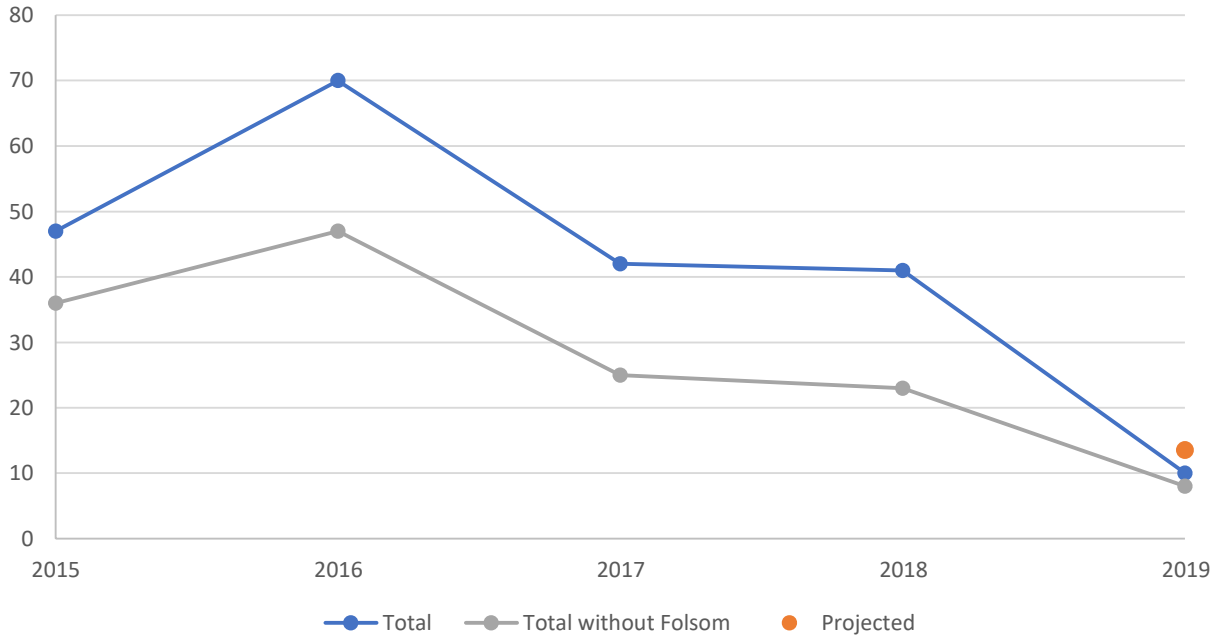
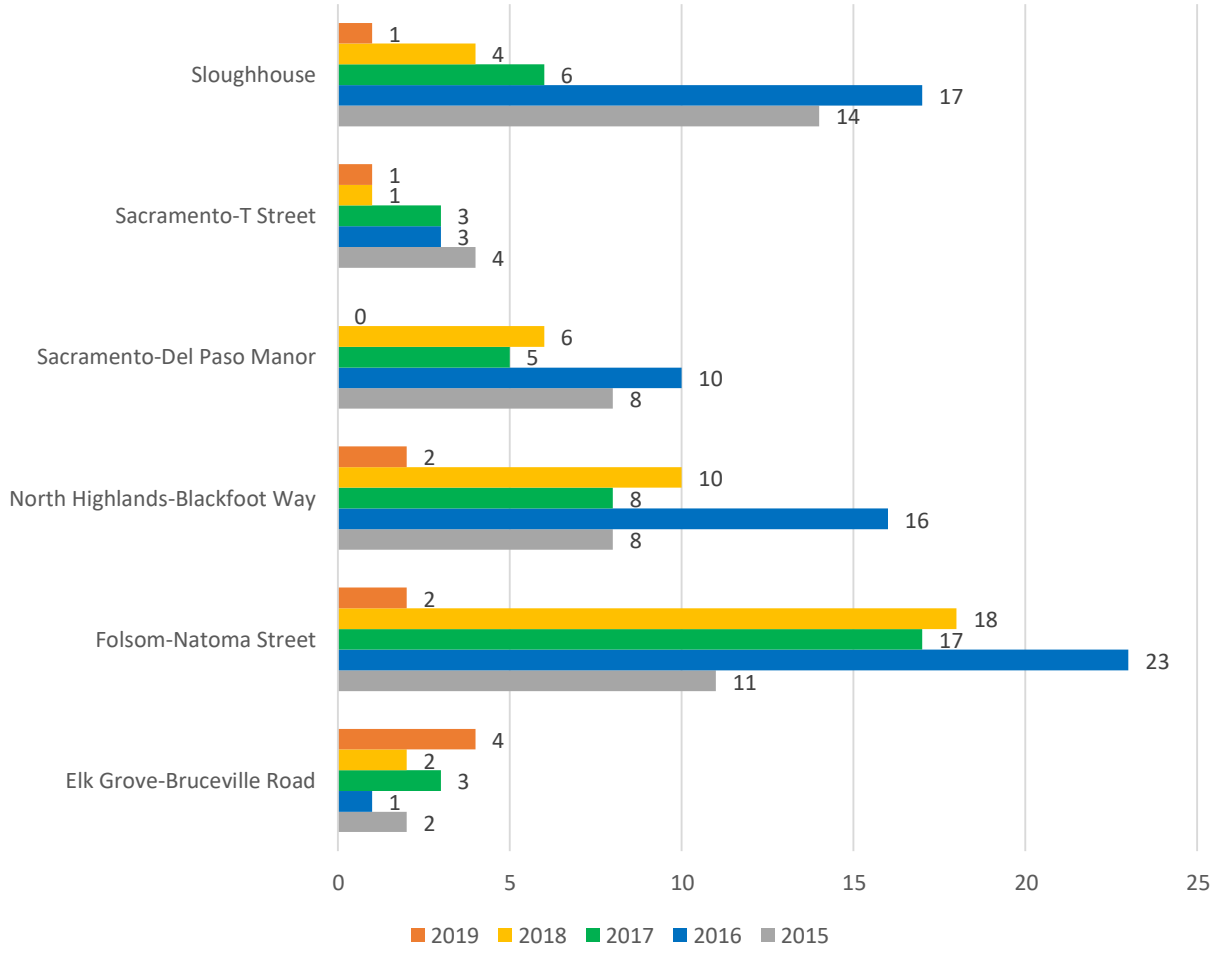


Figure 19 – Total number of 8-hour exceedances (2015 NAAQS of 70 ppb) in Sacramento County.



* Folsom-Natoma St. site was offline due to construction in late July 2019.

Figure 20 – Number of 8-hour exceedance days (2015 NAAQS of 70 ppb) by year for each site in Sacramento County for 2015-2019.

Throughout this analysis, days which may have been impacted by wildfire were included. This could introduce bias to the totals in years where wildfires heavily impacted Sacramento County. However, wildfire smoke has a nonlinear effect on ozone concentrations as light smoke can enhance ozone formation when VOC-rich wildfire smoke mixes into NOx-rich urban plumes[44], but heavy or thick smoke can inhibit incoming solar radiation (which also has the effect of decreasing daytime maximum temperatures) and therefore, decrease ozone formation. The average number of 8-hr ozone exceedances for the period 2015-2019 has decreased from the average between 2010-2014 from the previous 5-year Network Assessment. Figure 21 shows the cumulative number of exceedance days of the 0.070 ppm standard for the two periods in Sacramento County. This decrease in exceedance days could be a result of meteorological or climatological changes, fluctuations in wildfire impacts, consistent

[44] Lu Xu et al, Ozone chemistry in western U.S. wildfire plumes, Science Advances (2021). DOI: 10.1126/sciadv.abl3648

enforcement of regulations and rules, or a product of land use or mobile source changes within Sacramento County.

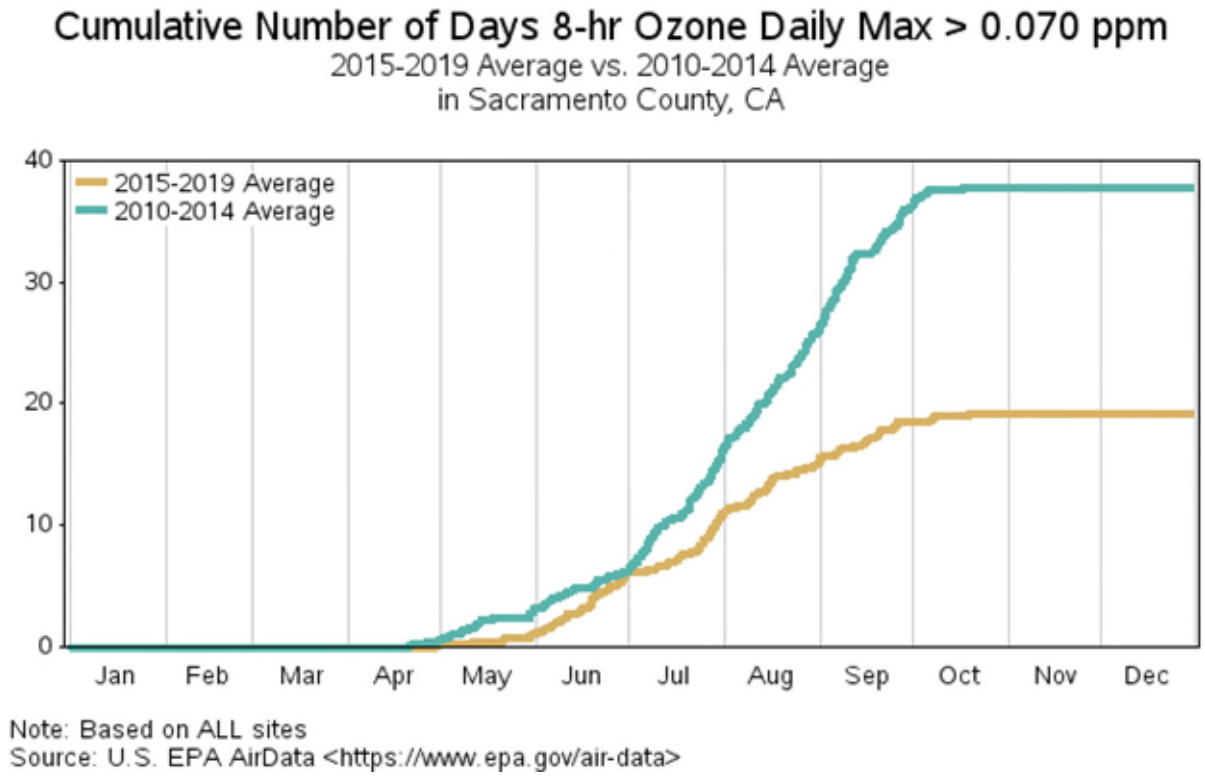


Figure 21 – Cumulative number of days exceeding 2015 8-hr NAAQS (0.070 ppm) for the periods 2010-2014 and 2015-2019.

Ozone Network Area- and Population-Served Analyses

Spatial analysis techniques were evaluated to determine whether the current ozone stations meet the objectives of the monitoring network. Thiessen polygons, as described in the previous section, were generated to determine the spatial representation of each of the six (6) ozone monitoring stations located in Sacramento County. The following sections present the findings for area- and population-served analyses for the ozone network. Note that as seen in Table 8, some ozone monitoring stations are affiliated with EPA networks and are therefore required regardless of these analyses.

The population within Sacramento County represented by each monitoring site was counted within the Thiessen polygons by NetAssess2020 v1.1 using 2010 US Census data. Area- and population-served analyses are presented in Table 8 and Table 10. Figure 22 presents a map showing the location and area of influence for each ozone monitor.

In the area-served analysis, sites are ranked based on their area of coverage. Sites that are used to represent a large area score high in this analysis. In the population-served analysis, large populations are associated with high emissions, and thus, sites are ranked based on the number of people they represent.

Following the methods outlined in the EPA network assessment guidance and the thresholds described in the Introduction to this document, Sloughhouse was found to be the most important ozone site based only on an area of influence exceeding 500 km^2; however, the population served by Sloughhouse is the smallest of the sites at less than the 159,000 persons threshold. Sacramento-1309 T Street and Sacramento-Del Paso Manor were found to be the most important based on population as these sites serve the most populous portions of Sacramento County at over the threshold of 317,000 persons each. Elk Grove-Bruceville serves an urbanized population over 159,000 people and is ranked as medium importance. The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 10. Minor changes to the rankings were observed as the Sacramento-Del Paso Manor site increased rank in Area-Served from low to medium. Site rankings are summarized in Table 10.

Table 10 – Area and population served by ozone monitors serving Sacramento County. Darker red indicates the highest values and therefore the most importance.

Station Name	Population Estimate (persons)*	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
Elk Grove-Bruceville	180,857	642	Medium	High
Folsom-Natoma St.	116,811	115	Low	Low
North Highlands-Blackfoot	151,035	118	Low	Low
Sacramento-1309 T Street	501,077	346	High	Medium
Sacramento-Del Paso Manor	320,584	240	High	Low
Sloughhouse	50,213	871	Low	High

North Highlands-Blackfoot Removed from Analysis

Station Name	Population Estimate (persons)*	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
Elk Grove-Bruceville	180,857	642	Medium	High
Folsom-Natoma St.	116,811	115	Low	Low
Sacramento-1309 T Street	505,572	354	High	Medium
Sacramento-Del Paso Manor	434,596	337	High	Medium
Sloughhouse	50,213	871	Low	High

* Population and area estimates based on monitor's area of influence and an approximate boundary of Sacramento County as extracted from the NetAssess2020 v1.1 tool. Population estimated with some overlapping census tracts.

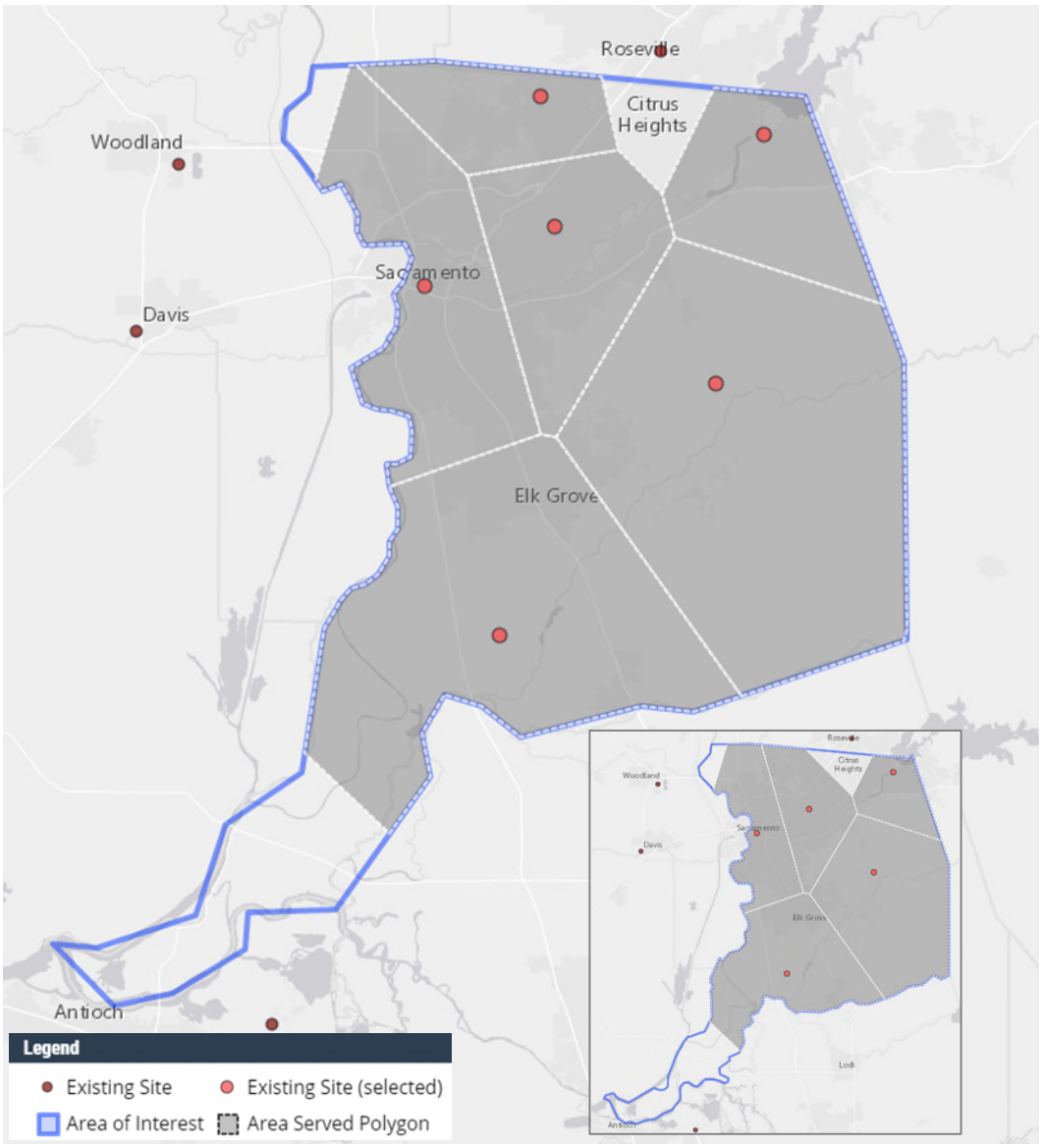


Figure 22 – Ozone Network Area-Served analysis. Inset shows analysis with the North Highlands-Blackfoot station removed.

Ozone Data Analyses

The ozone data analysis conducted was used to determine the importance of a site based on the following methods:

- measured concentrations and exceedance probability,
- deviation from NAAQS,
- monitor-to-monitor correlation,
- trend impact, and
- removal bias.

Measured Concentration and Exceedance Probability

The eight-hour ozone NAAQS of 70 ppb, as revised on October 1, 2015, was utilized for the exceedance probability calculations. Monitors within the District's ambient air monitoring network shown to have high levels of ozone, design values close to the standard, and with long historical record were considered to be of high value for characterizing pollution in an area. Table 11 presents 8-hour ozone design value concentrations for 2010 through 2019 (2010-2014 data included for historical context), deviation from the NAAQS using 2019 8-hr design value[45], and the exceedance probability for 2014-2016 in percent calculated using the NetAssess2020 v1.1 tool. The deviation from the NAAQS analysis will be discussed in the next section.

Table 11 – Concentration Analysis for Ozone Monitors Serving Sacramento County.

	Three-Year Calculated 8-hr Ozone Design Value (ppm)											
Station Name	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018[c]**	**2019**	**Deviation from NAAQS (ppm)[a]**	**Exceedance Probability[b]**
NH	0.075	0.077	0.077	0.076	0.075	0.074	0.077	0.078	0.078	0.074	0.004	>90%
DPM	0.085	0.081	0.078	0.077	0.077	0.076	0.077	0.077	0.075	0.071	0.001	>90%
TST	0.075	0.071	0.071	0.07	0.069	0.068	0.069	0.069	0.067	0.067	0.003	>90%
BRU	0.077	0.074	0.074	0.071	0.07	0.066	0.068	0.068	0.067	0.068	0.002	>90%
FOL	0.102	0.095	0.095	0.09	0.085	0.08	0.083	0.082	0.082	0.075	0.005	>90%
SLU	0.092	0.087	0.088	0.084	0.08	0.076	0.079	0.078	0.075	0.070	0.000	>90%

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor
TST – Sacramento-1309 T Street
BRU – Elk Grove-Bruceville
FOL – Folsom-Natoma St.
SLU – Sloughhouse

[a] Based on 2019 design values.
[b] Calculated by the NetAssess2020 v1.1 tool as described in the Sources of Data section.
[c] Wildfire smoke in 2018 impacted multiple air monitoring stations; the District will work with other monitoring organizations in the Sacramento Federal Non-attainment Area, CARB, and EPA in addressing some impacts under the Exceptional Event Rule (81 FR 68216) if necessary.

[45] The design value is calculated as the annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years, EPA, https://www.epa.gov/ground-level-ozone-pollution/table-historical-ozone-national-ambient-air-quality-standards-naaqs.

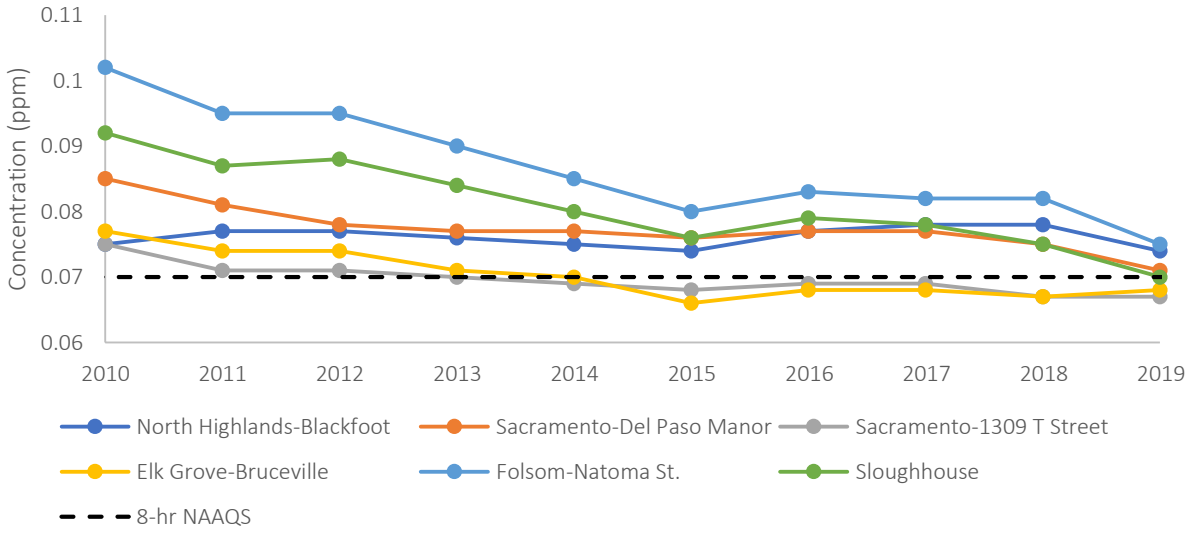


Figure 23 – 2010 through 2019 3-year design values for ozone monitors serving Sacramento County.

Figure 23 presents the 2010 through 2019 3-year design values for ozone monitors serving Sacramento County. As described in the introduction to this document, sites were ranked based on the average concentrations used to determine the design value (DV_{ave}) for the assessment period (2015-2019). The thresholds for this analysis are as follows:

Monitor Rank	Criteria
High	$DV_{ave} > 0.070$ ppm
Medium	$0.070 \text{ ppm} \geq DV_{ave} \geq 0.063$ ppm
Low	$DV_{ave} < 0.063$ ppm

Of monitoring stations located within Sacramento County, Folsom-Natoma, North Highlands-Blackfoot, Sacramento-Del Paso Manor and Sacramento-1309 T Street ranked as high importance. All other sites ranked as medium importance in this analysis. As previously mentioned, ozone forms through photochemical reactions in the presence of precursor pollutants and sunlight. These photochemical reactions take time, and the air masses typically get transported away from emission sources before ozone forms. Folsom-Natoma and Sloughhouse are located outside the urban core of the county where many of the ozone precursors are emitted. Ozone pollution roses are shown in Figure 24. This figure shows that on days with the highest 1-hr ozone concentrations, the wind direction is generally from the west, or transporting precursors from the urban areas where the ozone process begins, eastward towards the Folsom-Natoma and Sloughhouse sites where frequently the highest ozone concentrations are measured. The measured concentration rankings are compiled in Table 12.

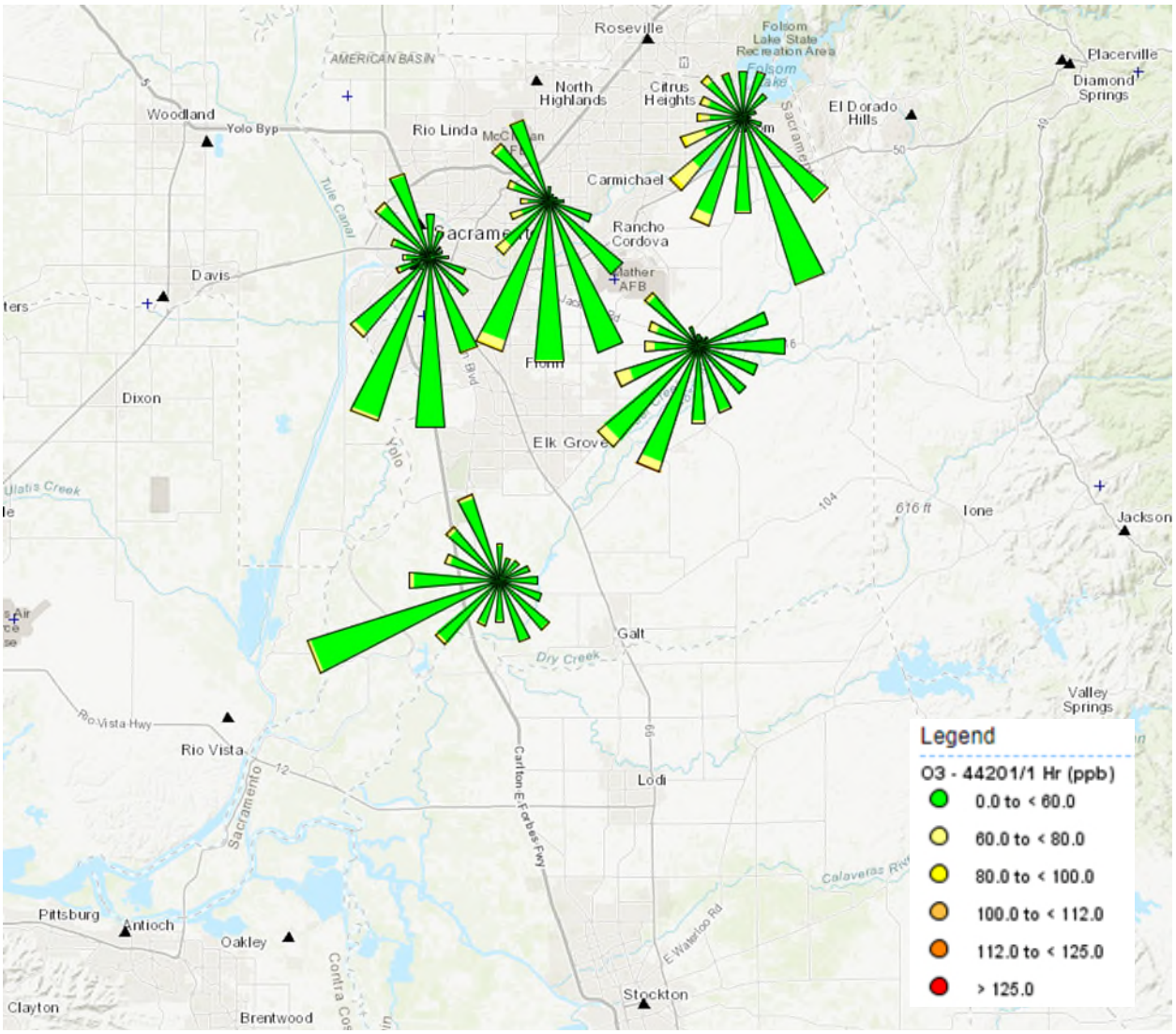


Figure 24 – Ozone pollution roses at Sacramento County air monitoring stations for January 2016 – December 2020 (source: AirNow-Tech; https://www.airnowtech.org/). The colors indicate hourly ozone concentrations in ppb.

As mentioned previously, the exceedance probability was calculated by applying a bootstrap analysis to the concentration outputs of 2014-2016 source data from the EPA Downscaler Model. Figure 25 shows the ozone monitoring stations overlaid on the calculated ozone exceedance probability. Each site in Sacramento County is determined to have a greater than 90% chance of exceeding the NAAQS. The exceedance probability presented in Table 11 is calculated for the Thiessen polygon which represents each site, not necessarily the exact geographical location of the monitor. Therefore, each site is ranked as high importance for the exceedance probability analysis (Table 12).

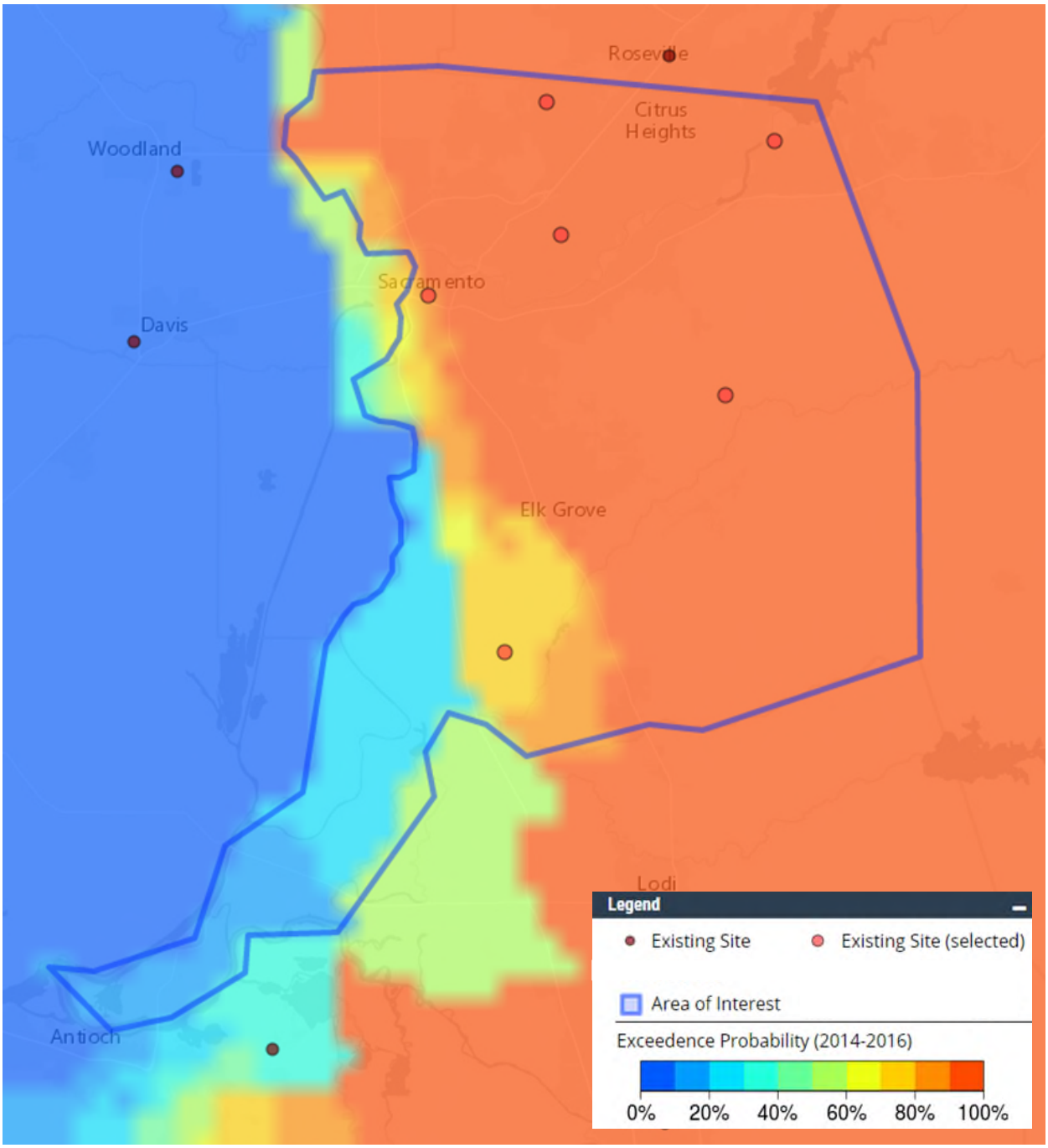


Figure 25 – Ozone monitoring stations overlaid on the calculated ozone exceedance probability (source: NetAssess2020 v1.1).

Table 12 – Measured concentration and exceedance probability ranking.

Station Name	Measured Concentrations	Exceedance Probability[a]
North Highlands-Blackfoot	Medium	High
Sacramento-Del Paso Manor	High	High
Sacramento-1309 T Street	High	High
Elk Grove-Bruceville	Medium	High
Folsom-Natoma St.	High	High
Sloughhouse	High	High

[a] Calculated by the NetAssess2020 v1.1 tool as described in the Sources of Data section.

Deviation from NAAQS

As shown in Table 13, the deviation from NAAQS analysis shows all sites are within the threshold for high importance as outlined in the introduction to this document (|Deviation| < 10% of NAAQS or 0.007 ppm).

Table 13 – 2019 ozone design value and deviation from NAAQS analysis.

Station Name	2019 O_3 Design Value (ppm)*	Deviation from NAAQS (ppm)**	Ranking***
North Highlands-Blackfoot	0.074	0.004	High
Sacramento-Del Paso Manor	0.071	0.001	High
Sacramento-1309 T Street	0.067	0.003	High
Elk Grove-Bruceville	0.068	0.002	High
Folsom-Natoma St.	0.075	0.005	High
Sloughhouse	0.070	0.000	High

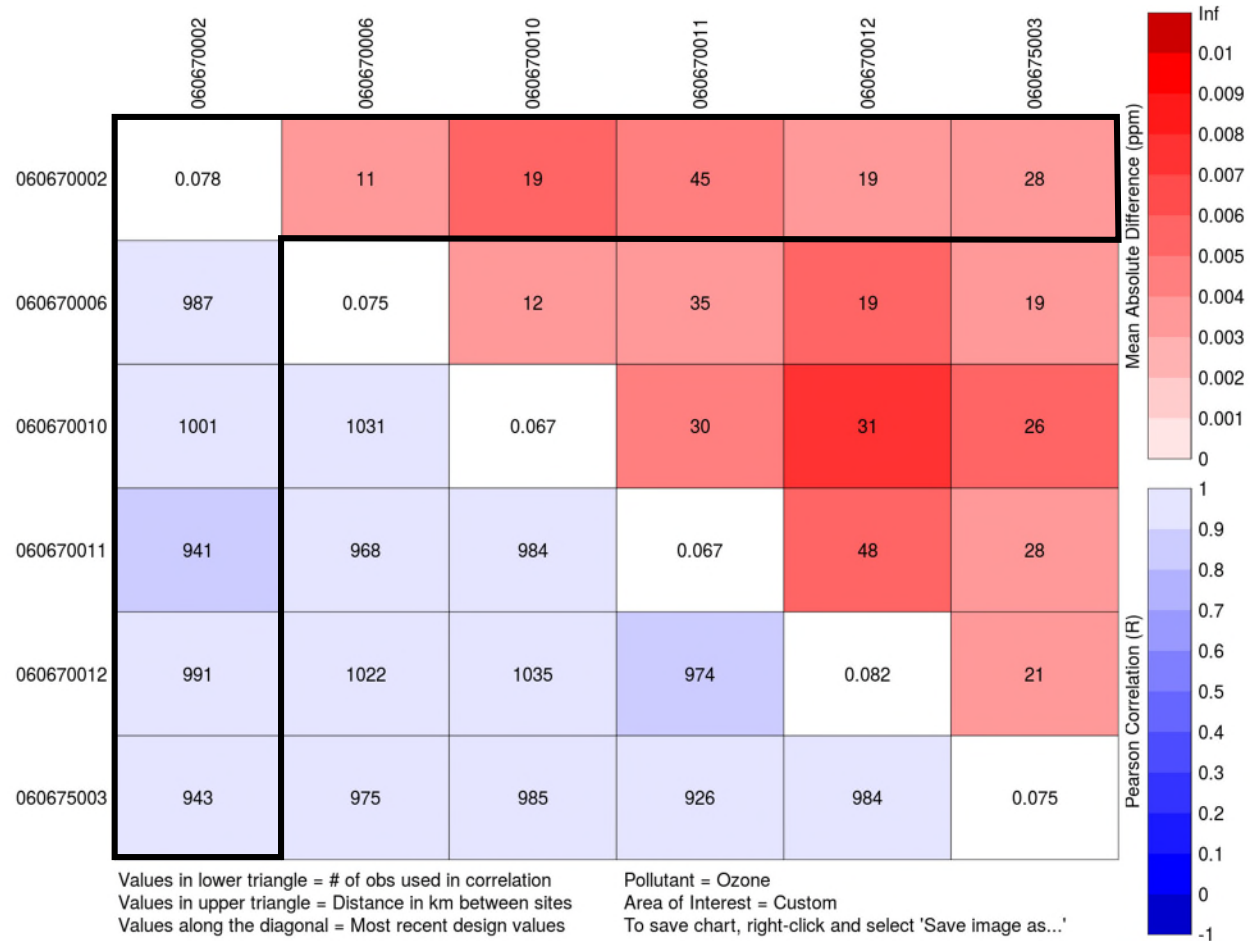
* Wildfire smoke in 2018 and 2020 impacted multiple air monitoring stations; the District is working with other monitoring organizations in the Sacramento Federal Non-attainment Area, CARB, and EPA in addressing possible impacts under the Exceptional Event Rule (81 FR 68216).
** Based on 2019 design values.
*** Ranking based on the most stringent 8-hour ozone NAAQS, which is the 2015 standard of 0.070 ppm.

Ozone Monitor-to-Monitor Correlation Analysis

Ozone concentrations were compared for redundancy using a correlation matrix analysis. Figure 26 shows a correlation matrix for all ozone monitors in Sacramento County provided by the NetAssess2020 v1.1 tool. The raw values from the correlation matrix are shown in Table 14. Included in the matrix are Pearson correlations, mean absolute differences, number of observations used in the correlation, distance in kilometers between the sites, and the 2018 design values. The correlation matrix helps to determine sites within the network that can be considered redundant. Sites with high correlation, low absolute difference, and close proximities are considered redundant in this analysis.

Monitor-to-monitor correlation analysis found that based on the square of the Pearson coefficients (R^2), all six of the monitors within Sacramento County were highly correlated ($R^2 > 0.9$) with at least one other monitor based on the highest pairwise R^2. As can be expected, monitors closer in proximity correlated better than those that were further apart. The mean absolute difference tended to increase as the east-west distance between the stations increased. This is due to the sites furthest west in the county sampling nearer the source of ozone precursor emissions and hence measuring lower ozone

concentrations, and the sites further east into the foothills, where ambient air has had time and distance for the photochemical production of ozone to occur, measuring elevated ozone concentrations.



60670002 – North Highlands-Blackfoot
60670006 – Sacramento-Del Paso Manor
60670010 – Sacramento-1309 T Street
60670011 – Elk Grove-Bruceville
60670012 – Folsom-Natoma St.
60675003 – Sloughhouse

Figure 26 – Correlation matrix for ozone monitors serving Sacramento County (source: NetAssess2020 v1.1). The lower triangle refers to the blue shaded boxes and the upper triangle refers to the red shaded boxes. Most recent design values are for the 2018 design value year. The area within the black box indicates correlations with the North Highlands-Blackfoot monitor.

Based on thresholds outlined in the Introduction of this document, the criteria for this analysis are as follows:

Monitor Rank	Criteria
High (meets 1 or less of the criteria)	Highest pairwise $R^2 > 0.75$
Medium (meets 2 of the criteria)	Distance between sites < 12 km
Low (meets 3 of the criteria)	Mean Difference < 0.0020 ppm

Table 14 – Monitor-to-monitor correlation data. **Red and bold** represent conditions considered to be redundant ($R^2 > 0.75$, distance between sites < 25% of maximum distance between any two sites, mean difference < 25% of maximum mean difference between any two sites). All correlations with the North Highlands-Blackfoot site are italicized.

Site #1	Site #2	Distance Between Sites (km)	Number of Observations	Pearson Correlation	Mean Difference (ppm)
NH	*DPM*	***11***	*987*	***0.9626***	*0.0035*
NH	*TST*	*19*	*1001*	***0.9291***	*0.0057*
NH	*BRU*	*45*	*941*	***0.8947***	*0.0047*
NH	*FOL*	*19*	*991*	***0.9534***	*0.0037*
NH	*SLU*	*28*	*943*	***0.9323***	*0.0037*
DPM	TST	**12**	1031	**0.9686**	0.0036
DPM	BRU	35	968	**0.932**	0.0037
DPM	FOL	19	1022	**0.9572**	0.0052
DPM	SLU	19	975	**0.9602**	0.0034
TST	BRU	30	984	**0.9371**	0.0041
TST	FOL	31	1035	**0.923**	0.0079
TST	SLU	26	985	**0.9359**	0.0057
BRU	FOL	48	974	**0.8991**	0.0058
BRU	SLU	28	926	**0.9512**	0.0035
FOL	SLU	21	984	**0.9542**	0.0036

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor
TST – Sacramento-1309 T Street
BRU – Elk Grove-Bruceville
FOL – Folsom-Natoma St.
SLU – Sloughhouse

This correlation analysis shows that the ozone sites in Sacramento County generate comparable data. This result is expected for ozone given the regional nature of ozone, the topography of Sacramento County, and the density of the ozone network. Even if the sites in the network measure comparable ozone levels (high correlation), the District prioritizes the importance of public reporting for health alerts and AQI levels, which necessitates a relatively dense ozone network to capture spatial variability. This may lead to a network of sites with high correlation and possible redundancy, but it will ultimately provide valuable data for the residents of Sacramento County to make healthy choices for themselves and their families. Based on this analysis alone, no sites meet all three criteria for redundancy and North Highlands-Blackfoot, Sacramento-Del Paso Manor, and Sacramento-1309 T Street monitors meet two of the three criteria and are therefore ranked as medium importance. All other sites meet one or less of the criteria and are ranked as high importance in this analysis. However, Sacramento-Del Paso Manor is the NCore[46] site for Sacramento County and is unsuitable for removal. The ranking of the sites is summarized in Table 15.

[46] https://www3.epa.gov/ttnamti1/ncore.html

Table 15 – Monitor-to-monitor correlation ranking.

Station Name	Monitor-to-Monitor Correlation Rank
North Highlands-Blackfoot	Medium
Sacramento-Del Paso Manor	Medium
Sacramento-1309 T Street	Medium
Elk Grove-Bruceville	High
Folsom-Natoma St.	High
Sloughhouse	High

Trend Analysis

Monitors that have a long historical record are valuable for tracking long-term trends. This helps with modeling and planning of pollutant concentrations as well as scientific research. In this analysis, sites are ranked based on the duration of the continuous measurement record as described in the Introduction to this document. The thresholds for this analysis are as follows:

Monitor Rank	Criteria
High	Trend ≥ 30 years
Medium	30 years > Trend ≥ 10 years
Low	Trend < 10 years

Table 16 shows the year that ozone measurements began at each of the stations serving Sacramento County. Based on this analysis, the North Highlands-Blackfoot, Sacramento-Del Paso Manor, and Sacramento-1309 T Street monitors are ranked as high importance and all other sites are ranked as medium.

Table 16 – Date of operation for each $PM_{2.5}$ station serving Sacramento County.

Station Name	Begin Year of Ozone Operation	Trend Rank
North Highlands-Blackfoot	1980	High
Sacramento-Del Paso Manor	1981	High
Sacramento-1309 T Street	1981	High
Elk Grove-Bruceville	1992	Medium
Folsom-Natoma St.	1996	Medium
Sloughhouse	1997	Medium

Ozone Monitor Removal Bias Analysis

Each monitor was analyzed to determine the change in spatial concentrations interpolated across Sacramento County if the monitor was removed. That is, the difference between a measured concentration from a particular site and what the concentration would be if it was removed and predicted by interpolation calculations. Table 17 and Figure 27 present the results of the removal bias analysis and the maximum change in ozone concentrations in Sacramento County if each ozone monitor in the District's network was individually removed as calculated by the NetAssess2020 v1.1 tool.

The change in concentration at a site indicates the bias which may be observed if the individual monitor were removed. Per the Network Assessment Guidance, "[t]he greater the bias, the more important the site is for interpolation." Based on the thresholds outlined in the Introduction to this document, the thresholds for this analysis are as follows, where MRB is the mean relative bias:

Monitor Rank	Criteria	Criteria (NH Removed)
High	|MRB| ≥ 0.0026 ppm	|MRB| ≥ 0.0023 ppm
Medium	0.0026 ppm > |MRB| ≥ 0.0009 ppm	0.0023 ppm > |MRB| ≥ 0.0008 ppm
Low	|MRB| < 0.0009 ppm	|MRB| < 0.0008 ppm

Table 17 below summarizes the mean removal bias for each monitor and shows that removal of the Sacramento-T Street ozone monitor could introduce a moderate bias in concentration interpolation. Based on this analysis, the Sacramento-1309 T Street ozone monitor is ranked as high importance. North Highlands-Blackfoot, Folsom-Natoma St., Elk Grove-Bruceville, and Sacramento-Del Paso Manor are ranked as medium importance. Sloughhouse is the only monitor ranked as low importance (see Table 18). The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 18. Minor changes to the rankings were observed as the Sacramento-Del Paso Manor site decreased rank from medium to low.

Table 17 – Ozone monitoring network removal bias results.

Station Name	Mean Removal Bias (ppm)	NH Station Removed: Mean Removal Bias (ppm)
North Highlands-Blackfoot	-0.0020	N/A
Sacramento-Del Paso Manor	0.0009	0.0002
Sacramento-1309 T Street	0.0034	0.0030
Elk Grove-Bruceville	-0.0009	-0.0009
Folsom-Natoma St.	-0.0020	-0.0020
Sloughhouse	-0.0001	-0.0001

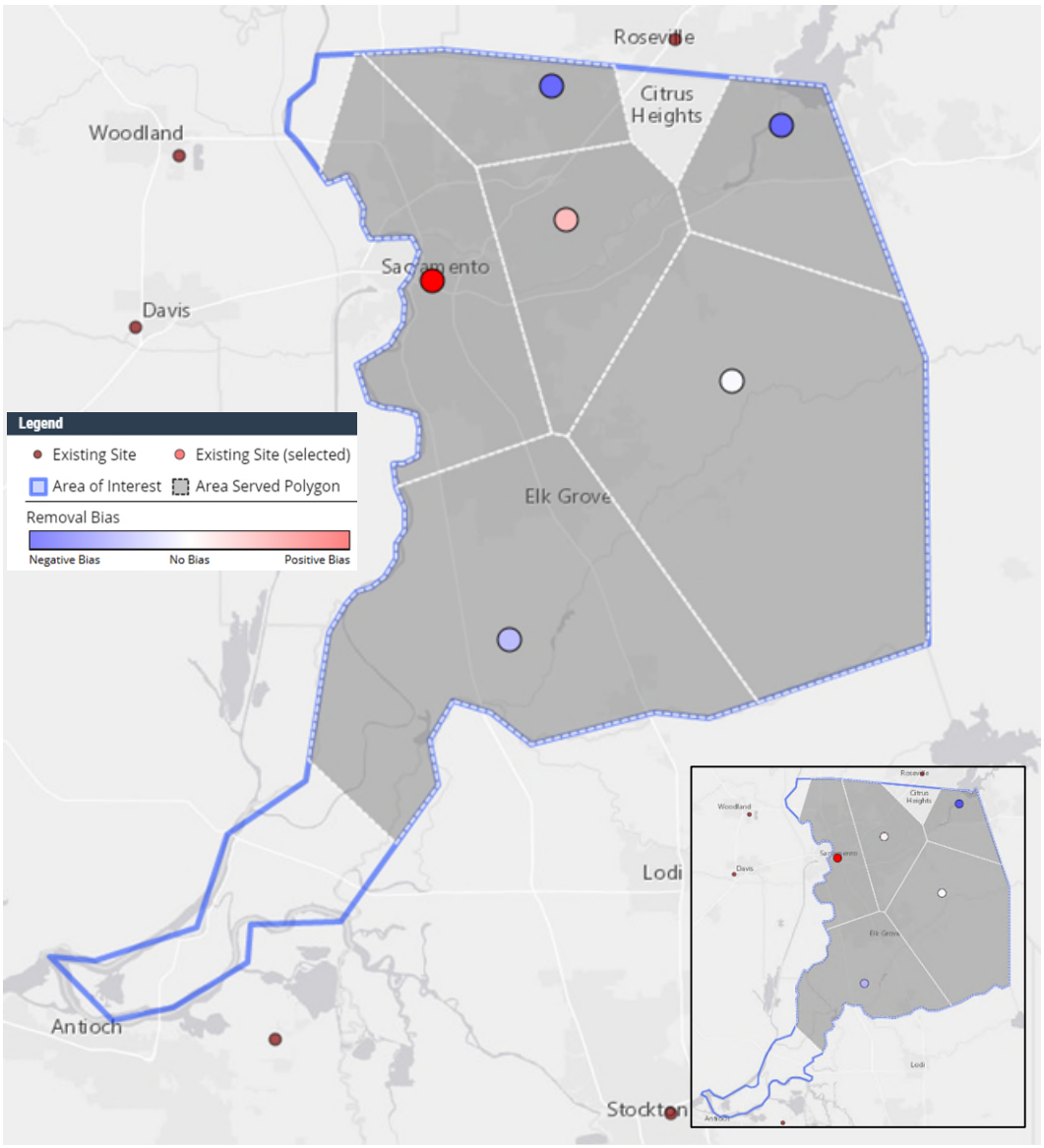


Figure 27 – Ozone removal bias analysis in Sacramento County (source: NetAssess2020 v1.1). Inset shows analysis with the North Highlands-Blackfoot station removed.

Table 18 – Ozone monitoring removal bias results.

Station Name	Removal Bias Rank	Removal Bias Rank NH Removed from Analysis
North Highlands-Blackfoot	Medium	
Sacramento-Del Paso Manor	Medium	Low
Sacramento-1309 T Street	High	High
Elk Grove-Bruceville	Low	Low
Folsom-Natoma St.	Medium	Medium
Sloughhouse	Low	Low

Ozone Minimum Number of Monitors Required

The minimum number of monitors required under Appendix D of 40 CFR Part 58 and number of sites in the Sacramento MSA are listed in Table 19. Note that there are six (6) sites in Sacramento County as shown in Figure 17. A CBSA with a population between 350,000 and 4,000,000 with the most recent three-year design value greater than 85 percent of the ozone NAAQS must have a minimum of two active ozone monitors. Furthermore, at least one ozone site within the MSA must be designed to record the maximum concentration for that particular area. The District currently has six (6) ozone monitors within its network (BRU, DPM, FOL, NH, SLU, TST).

Table 19 – Minimum monitoring requirements.

Sites Required	Sites in Sacramento MSA	Additional Sites Needed	2019 Design Value and Site ID
2	16	0	(1) 0.086 ppm at Auburn (06-061-0003) (2) 0.081 ppm at Auburn (06-061-0003)

Conclusions

Table 20 is a summary of the District's ozone monitor rankings from the analyses performed in this section. An overall ranking was calculated for each site by assigning a value to each rank (1 – low, 2 – medium, 3 – high) and summing over all analyses. Overall, all sites are ranked very closely with each other for this assessment. As ozone tends to behave as a regional pollutant in Sacramento County, the similarity of the overall scores demonstrates that all sites are considered important to the District network. Therefore, small differences in overall scores must not be misrepresented as large deviations in importance.

Table 20 – Ozone monitor ranking summary. Overall score is shaded red, with highest overall score darkest.

Station Name	Population-Served	Area-Served	Measured Concentrations	Exceedance Probability[a]	Deviation from NAAQS	Monitor-to-Monitor	Trend	Removal Bias	Overall
BRU	Medium	High	Medium	High	High	High	Medium	Medium	**20**
FOL	Low	Low	High	High	High	High	Medium	Medium	**18**
NH	Low	Low	High	High	High	Medium	High	Medium	**18**
TST	High	Medium	Medium	High	High	Medium	High	High	**21**
DPM	High	Low	High	High	High	Medium	High	Medium	**20**
SLU	Low	High	High	High	High	High	Medium	Low	**19**

North Highlands-Blackfoot Removed from Analysis

Station Name	Population-Served	Area-Served	Measured Concentrations	Exceedance Probability[a]	Deviation from NAAQS	Monitor-to-Monitor	Trend	Removal Bias	Overall
BRU	Medium	High	Medium	High	High	High	Medium	Low	**19**
FOL	Low	Low	High	High	High	High	Medium	Medium	**18**
TST	High	Medium	Medium	High	High	Medium	High	High	**21**
DPM	High	Medium	High	High	High	Medium	High	Low	**20**
SLU	Low	High	High	High	High	High	Medium	Low	**19**

Based on Table 20, the Sacramento-1309 T Street site ranks as the highest overall and therefore most important site for ozone. However, based on the scoring system of Table 20, all sites score within three points of Sacramento-1309 T Street indicating the importance of all sites within Sacramento County, even with the discontinuation of the North Highlands-Blackfoot station.

The unanticipated discontinuation of the North Highlands-Blackfoot station resulted in the removal of a long-term data point from the District network. As this was out of the control of the District and did not

follow the normal procedures for station removal, the removal of the station and associated ozone monitor was assessed to determine whether the ozone monitor should be replaced at a new station near the location of the previous station.

As the North Highlands-Blackfoot station is not the design value site in the SFNA and the number of ozone monitors in the SFNA far exceeds the minimum requirements, there are no ozone regulatory impacts of the station discontinuation. However, the station still holds significance for modeling. To further investigate this, ozone design values were interpolated for the region with and without the station. As shown in Figure 28, there is a small change in the location of the isoconcentration lines directly near the North Highlands-Blackfoot station. This minimal change is due to the relatively close proximity to the Sacramento-Del Paso Manor (C; 11.0 km) and the Roseville-N.Sunrise/Douglas (B; 10.8 km) stations. However, the value of the isoconcentrations in this area are very close to the NAAQS and the impact of this small shift on photochemical modeling is uncertain without further investigation outside the scope of this assessment.

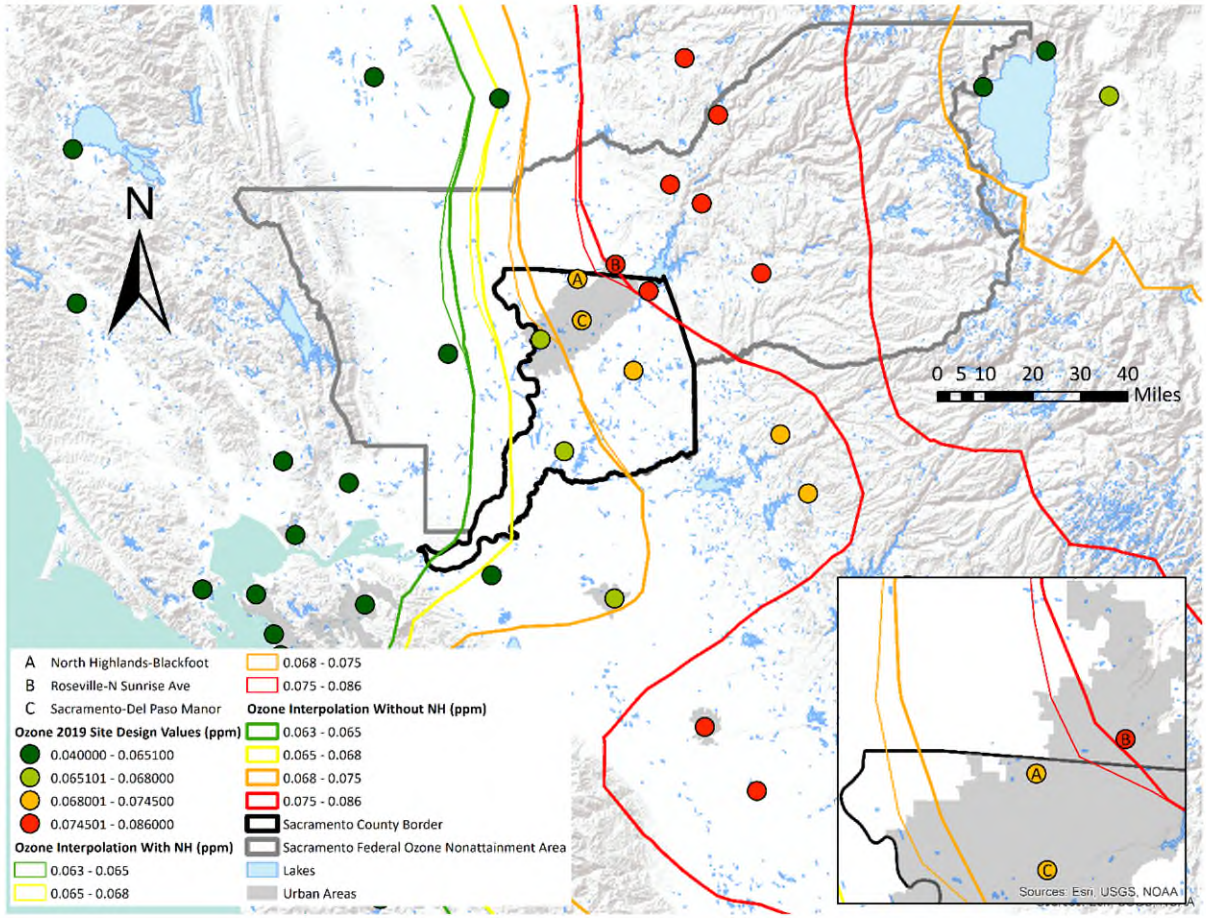
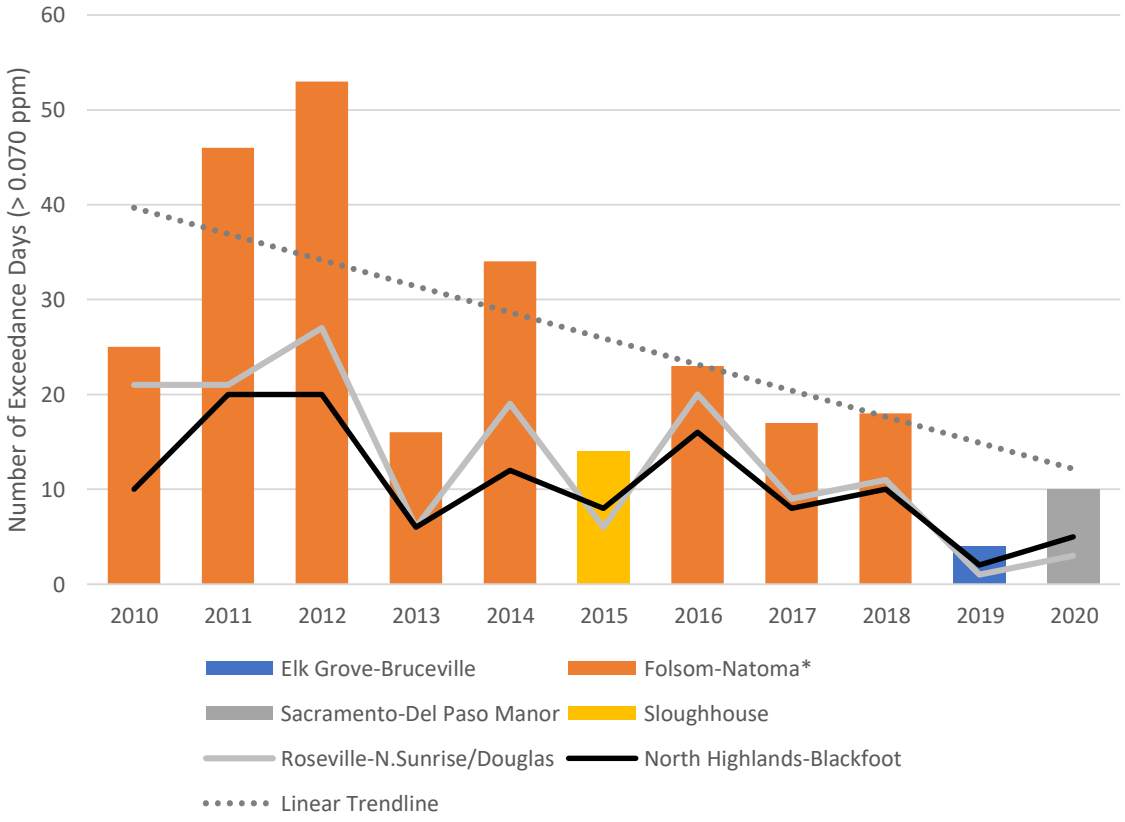


Figure 28 – Interpolated ozone design value isoconcentrations with and without the North Highlands-Blackfoot station (NH). North Highlands-Blackfoot, Roseville-N.Sunrise Ave., and Sacramento-Del Paso Manor sites are labeled with letters. All active sites are colored by 2019 ozone design value concentration. Inset shows a closer view of the area surrounding the North Highlands-Blackfoot station.

As mentioned previously, the highest ozone concentration sites in Sacramento County are located downwind (to the east) of the urban core of the Sacramento metropolitan area. This gradient is clearly shown in Figure 28. For the previous 10-year period (2010-2020) as seen in Figure 29, the North Highlands-Blackfoot station was never the maximum site from all the District stations for number of ozone exceedances of the 2015 NAAQS standard. In fact, the nearby Roseville-N.Sunrise/Douglas monitor sampled comparable number of ozone exceedances as the North Highlands-Blackfoot monitor during this period, and combined with the Sacramento-Del Paso Manor monitor, could be representative of the discontinued North Highlands-Blackfoot ozone monitor.

In terms of public notification, the removal of the North Highlands-Blackfoot station removes the northernmost station in Sacramento County. However, the Roseville-N.Sunrise site generally shows higher zone concentrations than the North Highlands-Blackfoot sites, which means that if the public uses information based on the Roseville-N.Sunrise, then the information will be more protective of public health.

This assessment recommends a replacement station for installation in this area to measure ozone concentrations if resources are available.



*Folsom-Natoma St. site was offline due to construction beginning late July 2019.

Figure 29 – Number of ozone exceedance days of the 0.070 ppb 2015 ozone NAAQS by year of the maximum station within Sacramento County. The number of ozone exceedances is shown for Roseville-N. Sunrise Ave. (gray line) and North Highlands-Blackfoot (black line). A linear trend of the maximum number of exceedances is shown as the gray dotted line.

As mentioned in this section, the design value for Sacramento is close to the NAAQS for the 8-hour standard. The highest concentrations occur during the warm summer months, when photochemical production of ozone is at its most efficient. Some of the sites are located close to the ozone precursor emission sources, some are located in rural areas representing background conditions, and some are located downwind of sources and therefore capture the highest concentrations. As can be seen from Table 20, all these sites have importance within the ozone network in Sacramento County. Whether that is for public notification within urban areas, to assist with modeling and research purposes by sampling background conditions, or to determine the maximum concentrations within the county, all sites provide important information and value to the overall network. An important aspect of the District ozone network is that all sites have long historical records, which is vital to understanding the changes to not only ozone in Sacramento County, but the Sacramento Federal Nonattainment Area and

throughout the interior of California. These records reflect multi-scale fluctuations to multiple earth systems, and provide important long-term information to aid research studies and possibly emission reduction strategies. Also, as some of the sites are included in various EPA monitoring programs (e.g. NCore and PAMS), the network adequately meets all EPA monitoring requirements and covers various ozone monitoring purposes consistent with District monitoring objectives.

In conclusion, the current ozone network for Sacramento County meets all federal requirements and adequately meets District monitoring objectives. There are no sites in Sacramento County recommended for removal. A single site is recommended for addition if resources are available. This recommendation is for a replacement station for the discontinued North Highlands-Blackfoot station to measure ozone concentrations near the previous location.

Fine Particulate Matter ($PM_{2.5}$) Network Analysis

Monitoring Objectives

Sacramento County has a total of six (6) active SLAMS $PM_{2.5}$ monitoring stations as shown in Figure 30. Based on the characteristics of the sites, including the population served and the area served, each site can be designated as background, population oriented, source oriented, or high concentration monitoring locations as listed in Table 21. Table 21 also includes the EPA network affiliation for each site. The Elk Grove-Bruceville site operates a non-FEM $PM_{2.5}$ monitor, suitable for public information and forecasting, and is not included in design value calculations for comparison to the NAAQS.

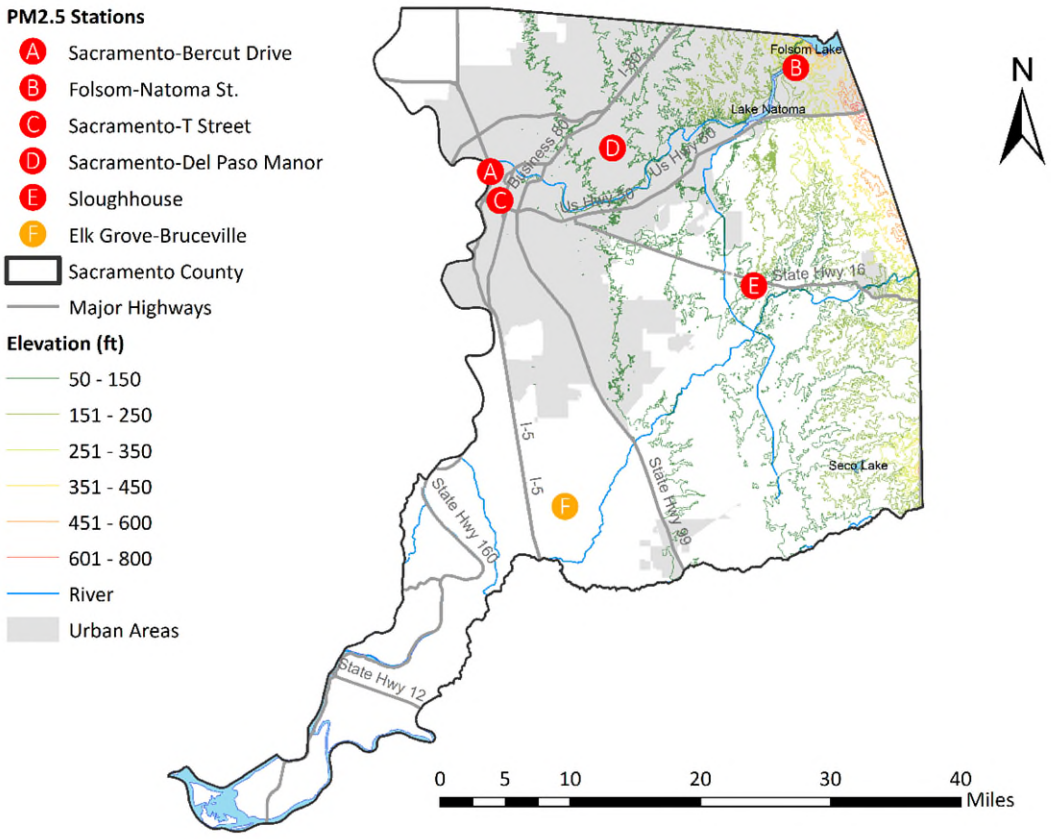


Figure 30 – $PM_{2.5}$ Network in Sacramento County. Red dots mark FEM/FRM monitors, and orange dots mark non-FEM monitors. Colored lines show elevation above sea level in feet.

Table 21 – EPA network affiliation and monitoring objective for $PM_{2.5}$ monitors serving Sacramento County.

Site	EPA Network Affiliation*	Monitoring Type**
Sacramento-Del Paso Manor	NCORE, CSN	Population Oriented / High Concentration
Sacramento-1309 T Street	CSN	Population Oriented
Folsom-Natoma St.	PAMS	Population Oriented
Sloughhouse		Background
Sacramento-Bercut Drive	Near Road	Source Oriented
Elk Grove-Bruceville Rd.	PAMS	Background

Note: All monitors are SLAMS (State and Local Air Monitoring Stations) monitor type unless otherwise noted.
* NCORE (National Core Multi-pollutant Monitoring Stations), PAMS (Photochemical Assessment Monitoring Station), CSN (Chemical Speciation Network).
** Consistent with EPA monitoring types as listed in 40 CFR Part 58, Appendix D.

In 1997, EPA completed a review of the $PM_{2.5}$ NAAQS and established a $PM_{2.5}$ Chemical Speciation Network (CSN) whose goal is to provide supplemental speciation information used for multiple objectives. EPA[47] outlines these objectives as:

- The assessment of trends;
- The development of effective State Implementation Plans (SIPs) and determination of regulatory compliance;
- The development of emission control strategies and tracking progress of control programs;
- Aiding in the interpretation of health studies by linking effects to PM2.5 constituents;
- Characterizing annual and seasonal spatial variation of aerosols; and
- Comparison to chemical speciation data collected from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network.

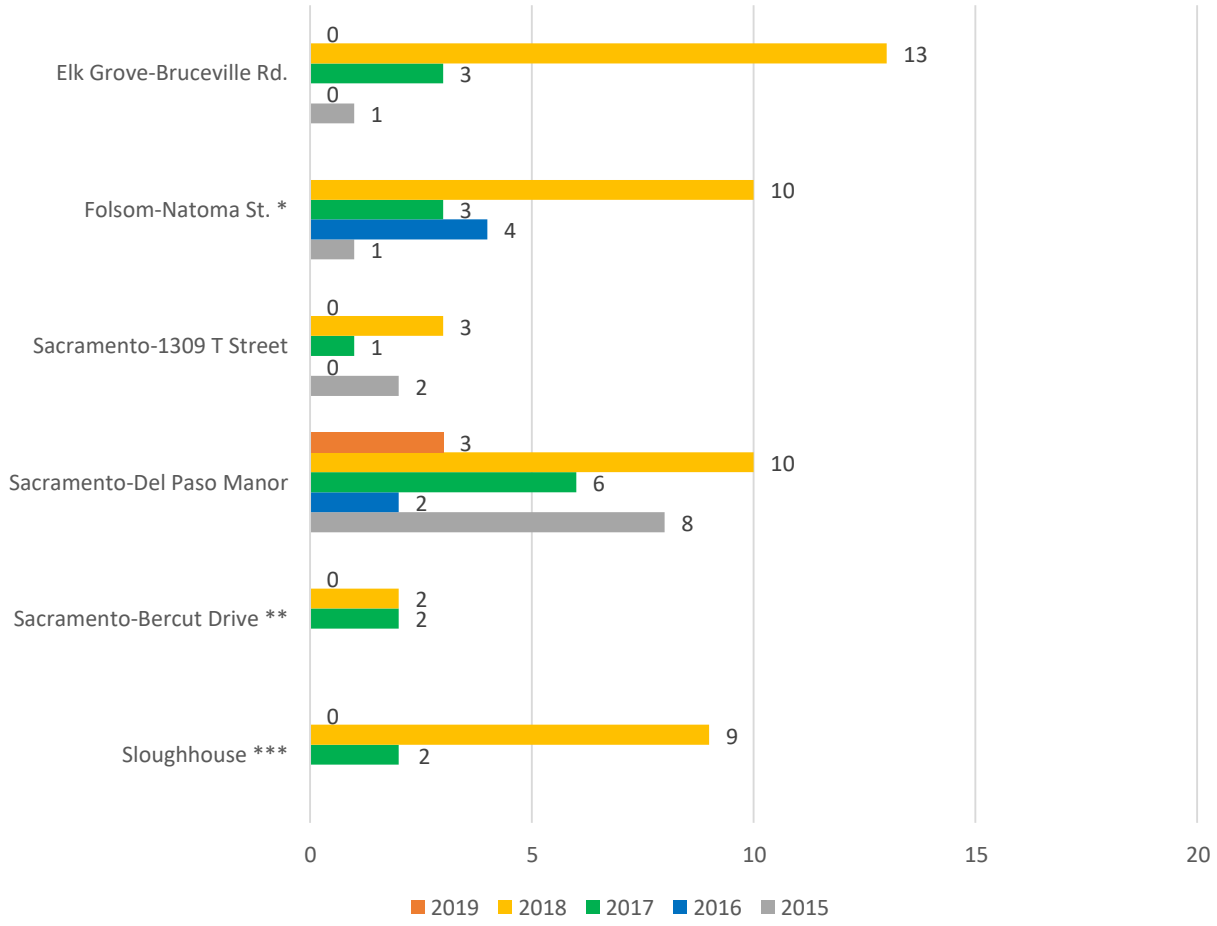
The District operates a single CSN site at the Sacramento-Del Paso Manor station. The District network meets all federal CSN requirements and District monitoring objectives.

In Sacramento County, ambient $PM_{2.5}$ concentrations are typically elevated during the winter months. Meteorological conditions in Sacramento County during these months are conducive to particulate matter buildup, with factors such as relatively higher humidity than in the summer months, lower mixing heights as the temperature is lowered and hours of sunlight are decreased, increased fog formation especially near water sources with minimal change in elevation, and frequent temperature inversions near the surface. The cooler winters also cause an increase in the amount of residential wood burning, which is a major source of $PM_{2.5}$ in the winter months. As seen in Figure 30, the urban areas within Sacramento County are generally at low elevation with very little terrain difference and close proximity to water sources. This provides ideal land surface conditions for particulate matter to settle just above the ground under inversion conditions. These factors combined can lead to elevated $PM_{2.5}$ concentrations near the surface.

For 2015-2019, the number of daily average 24-hour exceedance days exceeding the federal standard (greater than 35 µg m^{-3}) were calculated for each site and shown in Figure 31 – Number of days

[47] EPA Ambient Monitoring Technology Information Center (AMTIC) Chemical Speciation Network (CSN): https://www.epa.gov/amtic/chemical-speciation-network-csn.

exceeding the 24-hour NAAQS (35 µg m-3) by year for each site in Sacramento County (source: EPA AQS). The exceedances were counted as number of station days that exceeded the 24-hour $PM_{2.5}$ standard, so multiple exceedances from collocated monitors at a single station were not counted.



* Due to construction at Folsom-Natoma St. site, data offline July 2019 – December 2020
** Sacramento-Bercut Drive Site came online in December 2016
*** Sloughhouse FEM monitor came online June 2017, non-FEM prior.

Figure 31 – Number of days exceeding the 24-hour NAAQS (35 µg m-3) by year for each site in Sacramento County (source: EPA AQS)

Solely analyzing the number of exceedance days in Sacramento County can provide a misleading assessment of the importance of each site, however. The totals fluctuate from year to year due to extraordinary events, most notably wildfires. As mentioned in the Natural Event Impacts on the Monitoring Network section, 2018 was a highly impacted year for wildfire smoke. As seen in Figure 32, there were periods of very high AQI values in 2018. The fall of 2018 was impacted by the Camp Fire wildfire north of Sacramento.

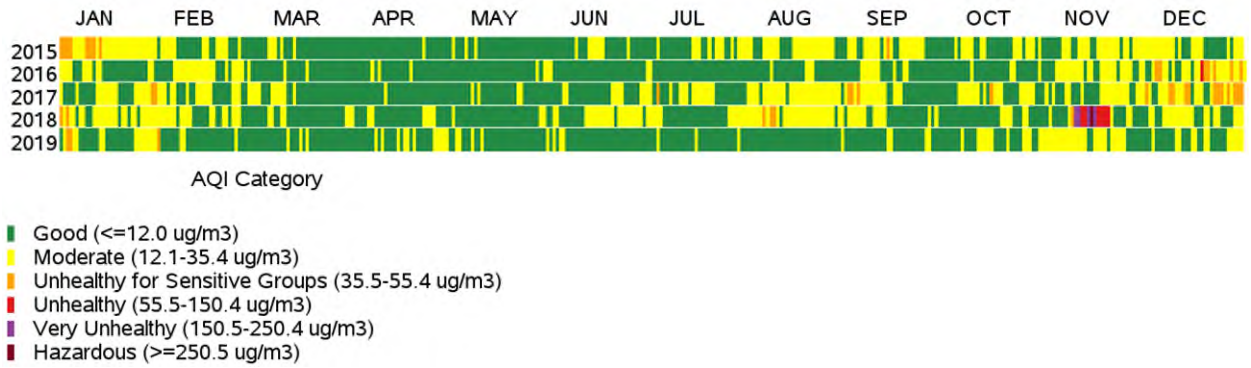


Figure 32 – $PM_{2.5}$ daily AQI data for Sacramento County (Source: EPA AirData).

In years without significant wildfire impacts, the Sacramento-Del Paso Manor site measures the most exceedances on average. This is mainly due to its residential location where in the winter months residential wood burning in Sacramento County becomes a prominent source of ground-level $PM_{2.5}$ pollution, averaging more than 60% of the total winter average $PM_{2.5}$ over 2015-2019[48] as seen in Figure 33. Therefore, under normal wintertime conditions, the sites located within residential communities tend to measure the most exceedances.

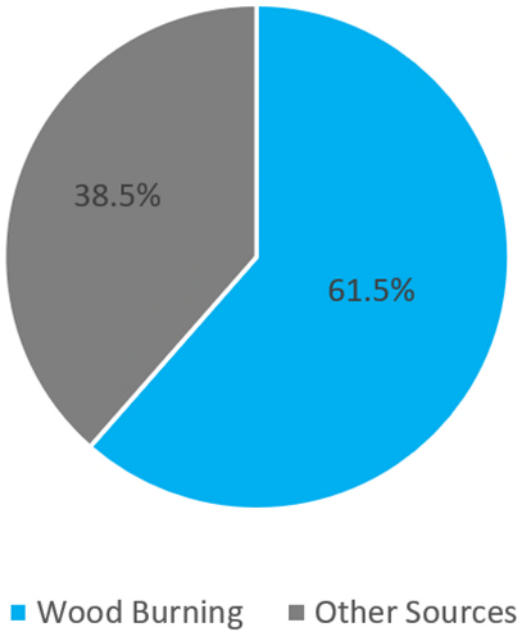


Figure 33 – Percentage of wood burning $PM_{2.5}$ to the total winter average $PM_{2.5}$ emissions for Sacramento County averaged over 2015-2019 (Source: ARB CEPAM).

[48] https://ww2.arb.ca.gov/criteria-pollutant-emission-inventory-data

$PM_{2.5}$ Network Area- and Population-Served Analyses

Spatial analysis techniques were evaluated to determine whether the current $PM_{2.5}$ stations meet the objectives of the monitoring network. Thiessen polygons, as described previously, were generated by the NetAssess2020 v1.1 tool to determine the spatial representation of each of the six (6) $PM_{2.5}$ monitoring stations located in Sacramento County. The following sections present the findings for area- and population-served analyses for the $PM_{2.5}$ network. Note that as seen in Table 21, some of the $PM_{2.5}$ stations are affiliated with EPA networks and are, therefore, required regardless of these analyses.

The population within Sacramento County represented by each monitoring site was counted within the Thiessen polygons by NetAssess2020 v1.1 using 2010 US Census data. Area- and population-served analyses are presented in Table 21 and Table 22. Figure 34 presents a map showing the location and area of influence for each $PM_{2.5}$ monitor.

Following the methods outlined in the Network Assessment Guidance and the thresholds described in the Introduction of this document, Sloughhouse and Elk Grove-Bruceville were found to be the most important $PM_{2.5}$ sites based solely on areas of influence exceeding the 500 km^2 threshold. However, the population served by Sloughhouse is the smallest of the sites and falls below the 159,000 persons threshold. Therefore Sloughhouse is ranked as low importance for this analysis. Sacramento-1309 T Street and Sacramento-Del Paso Manor serve the most populous portions of Sacramento County exceeding the threshold of 317,000 persons each and are therefore ranked as high importance in this analysis. Site rankings are summarized in Table 22.

Table 22 – Area and population served by $PM_{2.5}$ monitors serving Sacramento County. Darker red indicates the highest values and therefore the most importance.

Station Name	Population Estimate (persons)*	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
Sacramento-Del Paso Manor	423,465	326	High	Medium
Sacramento-1309 T Street	367,698	171	High	Low
Folsom-Natoma St.	116,811	115	Low	Low
Sloughhouse	50,213	871	Low	High
Sacramento-Bercut Drive	149,005	193	Low	Low
Elk Grove-Bruceville	182,841	758	Medium	High

* Population and area estimates based on monitor's area of influence and an approximate boundary of Sacramento County as extracted from the NetAssess2020 v1.1 tool. Population estimated with some overlapping census tracts.

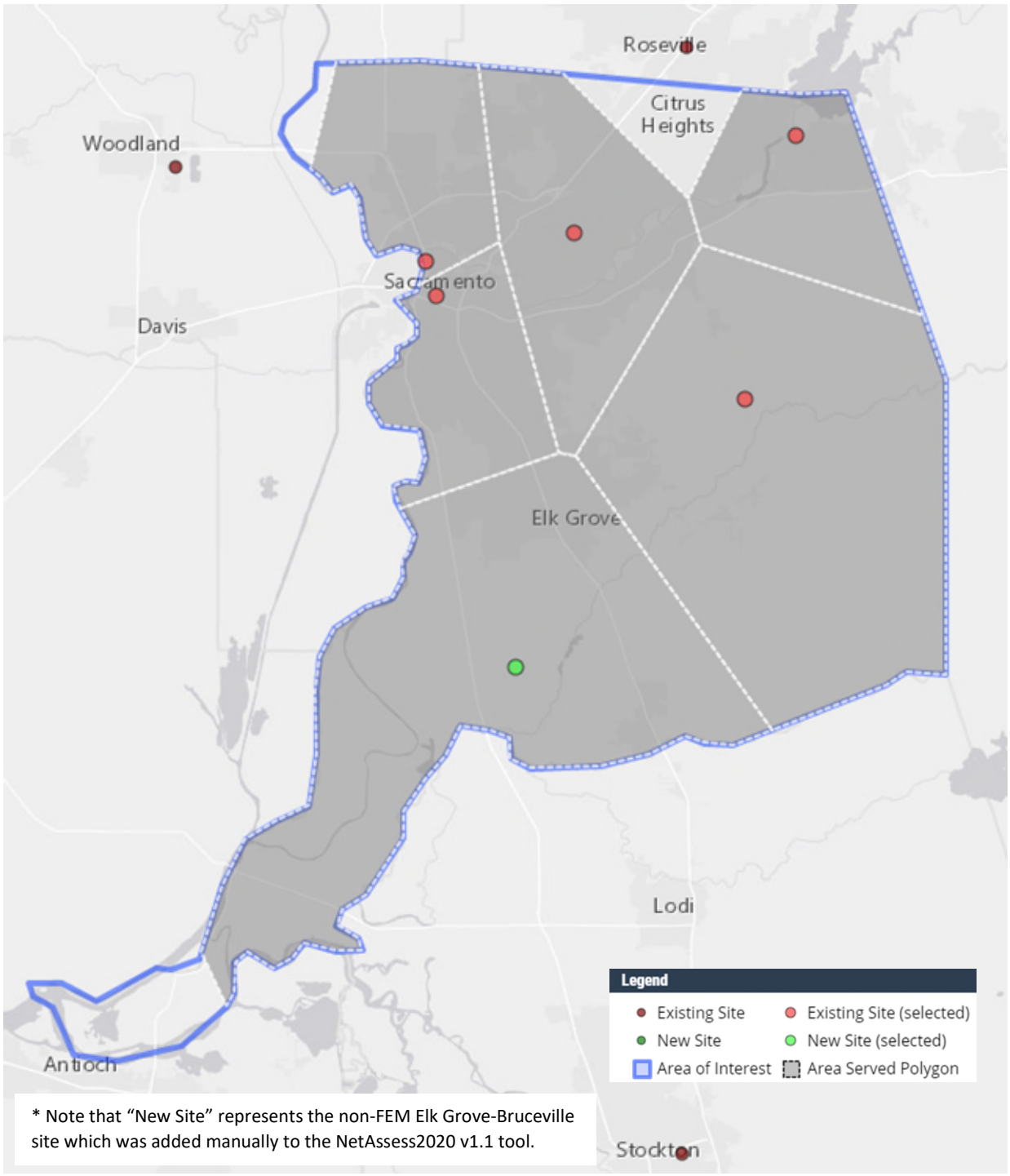


Figure 34 – $PM_{2.5}$ Network Area-Served.

$PM_{2.5}$ Data Analyses

The $PM_{2.5}$ data analysis conducted was used to determine the importance of a site based on the following methods:

- measured concentrations and exceedance probability,
- deviation from NAAQS,
- monitor-to-monitor correlation,
- trend impact, and
- removal bias.

Measured Concentration and Exceedance Probability Analysis

The 2006 24-hour $PM_{2.5}$ NAAQS[49] of 35 µg m^{-3} was utilized for the exceedance probability calculations. The 2012 annual $PM_{2.5}$ NAAQS[50] is 12 µg m^{-3}. Monitors within the District's ambient air monitoring network shown to have high levels of $PM_{2.5}$, design values close to the standard, and with long historical record were considered to be of high value for characterizing pollution in an area. Table 11 presents 24-hour and annual $PM_{2.5}$ design value concentrations for 2010 through 2019 (2010-2014 data included for historical context), deviation from the NAAQS for the 2017 through 2019 24-hour and annual design values, and the 24-hour exceedance probability for 2014-2016 in percent calculated using the NetAssess2020 v1.1 tool. The deviation from the NAAQS analysis will be discussed in the next section.

[49] The 24-hour design value is calculated as the 3-year average of annual 98th percentile 24-hour average values recorded at each monitoring site and the annual design value is calculated as the annual arithmetic mean averaged over 3 years at each monitoring site, EPA, https://www.epa.gov/pm-pollution/timeline-particulate-matter-pm-national-ambient-air-quality-standards-naaqs.

[50] The annual design value is calculated as the annual arithmetic mean concentrations, averaged over 3 years.

Table 23 – Concentration analysis for $PM_{2.5}$ monitors serving Sacramento County. **Bold and underlined** numbers exceed the NAAQS[49,50] (source: EPA AQS).

	Three-Year Calculated 24-hr $PM_{2.5}$ Design Value (µg m^{-3})											
Station Name	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018[c]**	**2019[d]**	**Deviation from NAAQS (µg m^{-3})[a]**	**Exceedance Probability[b]**
DPM	**40**	35	31	**36**	32	35	31	34	**37**	**37**	2	25%-50%
FOL							20	21	29			<10%
BER										30[e]	5	<10%
SLU*												75%-90%
TST	34	33	31	33	26	30	27	30	34	34	1	50%-75%
BRU**						28	25	27	27	27	9	N/A
	Three-Year Calculated Annual $PM_{2.5}$ Design Value (µg m^{-3})											
DPM	10.9	10.0	9.5	10.4	9.8	10.2	9.3	9.6	10.4	10.2	1.8	
FOL							7.3	7.4	8.0			
BER										9.9	2.1	
SLU*												
TST	9.5	9.2	8.8	9.5	9.0	9.5	8.7	8.9	9.4	9.4	2.6	
BRU**						10.4	10.7	10.2	9	7.9	4.1	

DPM – Sacramento-Del Paso Manor
FOL – Folsom-Natoma St.
BER – Sacramento-Bercut Dr.
SLU – Sloughhouse
TST – Sacramento-1309 T Street
BRU – Elk Grove-Bruceville

[a] Based on 2019 design values.

[b] Calculated by the NetAssess2020 v1.1 tool as described in the Sources of Data section, independent of design value calculations.

[c] Wildfire smoke in 2018 impacted multiple air monitoring stations; the District is working with other monitoring organizations in the Sacramento Federal Non-attainment Area, CARB, and EPA in addressing possible impacts under the Exceptional Event Rule (81 FR 68216). Data from 11/9/2018 – 11/21/2018 were removed from calculation for BRU due to exceptional impacts from wildfire.

[d] Folsom-Natoma St. site was offline due to construction in late July 2019, therefore not meeting data completeness requirements for a valid design value in 2019.

[e] Sacramento-Bercut Drive came online October 2015, due to instrument malfunctions and data completeness requirements, first valid 3-year design value is 2019.

* Sloughhouse monitor came online May 2017, therefore there are no valid 3-year design values in the assessment period.

** Elk Grove-Bruceville monitor is non-FEM, therefore design values are not valid, only an estimate for comparison purposes.

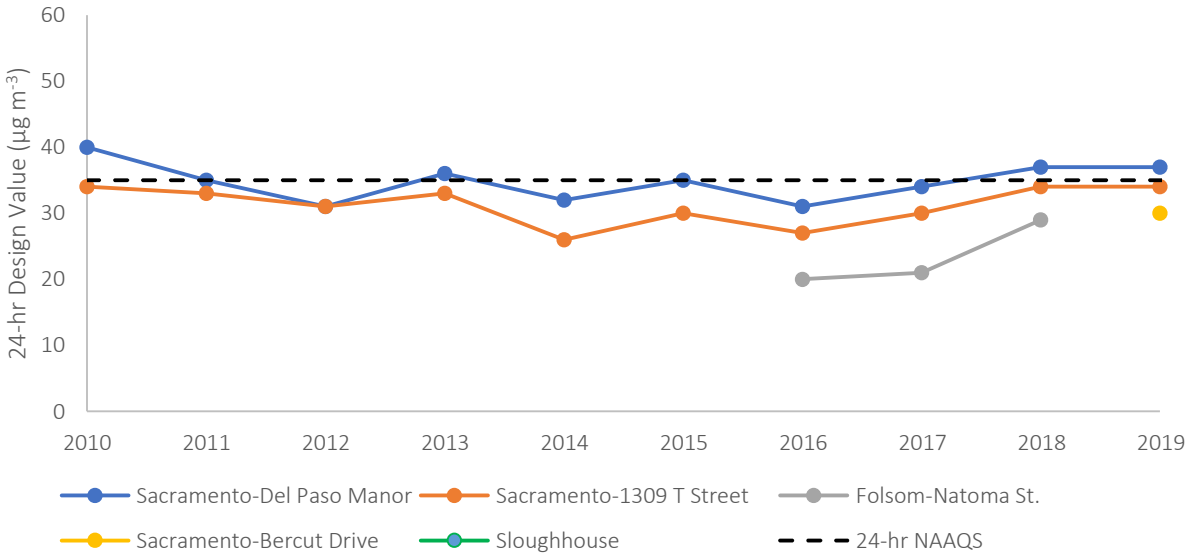


Figure 35 – Valid 24-hr PM2.5 design value trend (Source: EPA AQS).

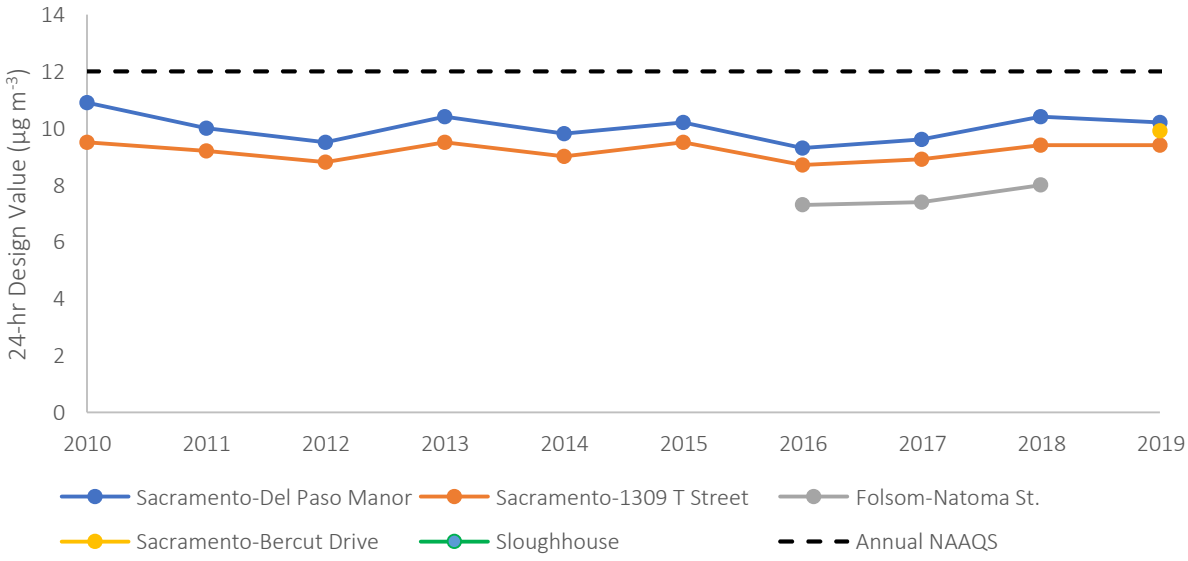


Figure 36 – Valid annual $PM_{2.5}$ design value trend (Source: EPA AQS).

Figure 35 and Figure 36 present the 2010 through 2019 valid 3-year 24-hour and annual design values for $PM_{2.5}$ monitors serving Sacramento County. Of the monitoring stations located within Sacramento County, Sacramento-Del Paso Manor has historically had the highest concentrations, followed by Sacramento-1309 T Street. As seen in Figure 33, residential wood burning is a significant source of ground-level $PM_{2.5}$ in Sacramento County. In October 2007, the District adopted the Check Before You Burn rule (Rule 421 Mandatory Episodic Curtailment Of Wood And Other Solid Fuel Burning[51]), which

[51] http://www.airquality.org/ProgramCoordination/Documents/rule421.pdf

restricts or prohibits the use of all fireplaces, woodstoves, inserts and pellet stoves when $PM_{2.5}$ is forecast to be high. This rule has helped to decrease wintertime $PM_{2.5}$ concentrations throughout the county and bring the 24-hour $PM_{2.5}$ design values closer to attainment of the NAAQS.

However, as previously mentioned, wildfire smoke has become an increasingly frequent source of summer and fall $PM_{2.5}$. During these large-scale events, it is typical that all monitors within the county are impacted by regional wildfire smoke. National Aeronautics and Space Administration (NASA) satellite images show the scale of the smoke during the devastating Camp Fire wildfire from 2018 (Figure 37). The impact of the smoke can vary throughout the county depending on wind direction and speed, terrain, ground cover, and boundary layer height or vertical mixing. Therefore, it is difficult to rank any site within Sacramento County as low importance.

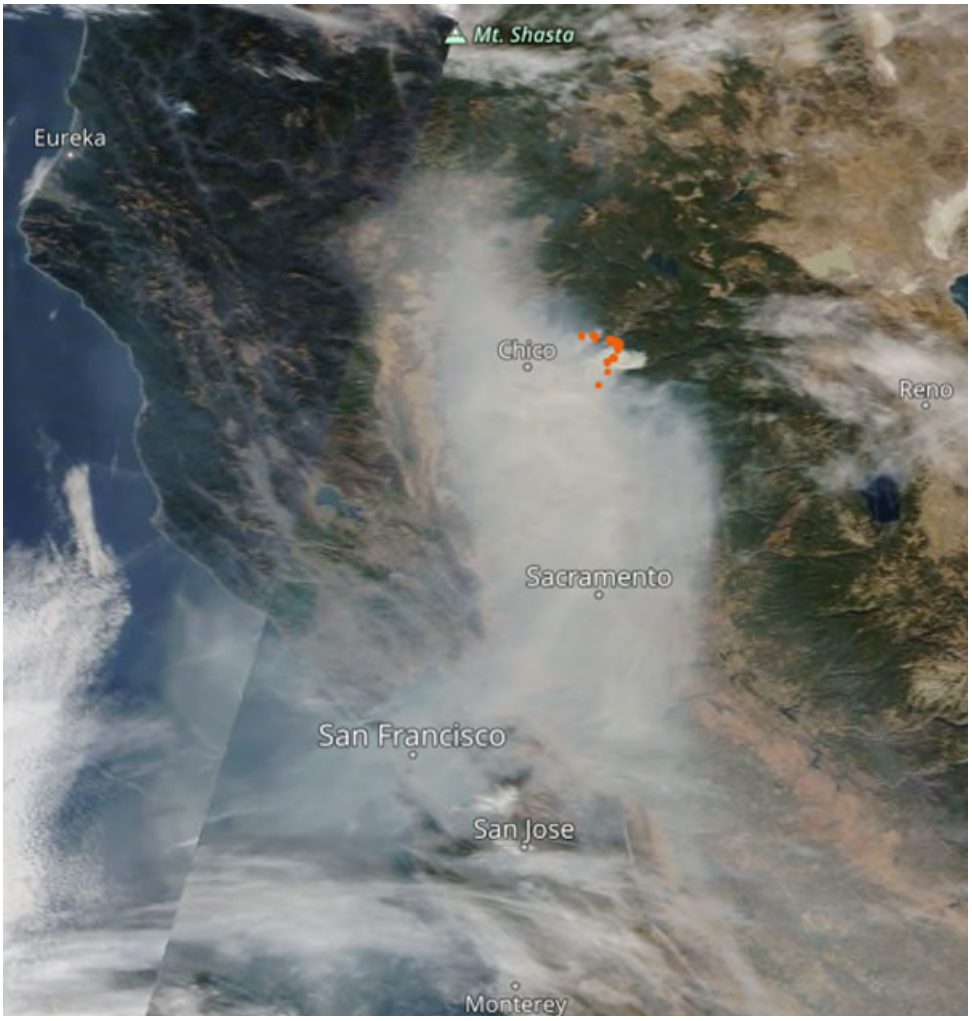


Figure 37 – Satellite imagery from November 15, 2018 showing wildfire smoke throughout California (Source: NASA; https://worldview.earthdata.nasa.gov/). Image from the Terra/MODIS satellites in corrected reflectance (true color), satellite derived fires and thermal anomalies are shown as red dots.

Wildfire smoke in 2018 impacted multiple air monitoring stations throughout California. The District is working with other monitoring organizations in the Sacramento Federal Non-attainment Area, CARB, and EPA in addressing possible impacts under the Exceptional Event Rule (EE, 81 FR 68216). The District

provided initial notification to EPA on August 19, 2019, regarding these impacts. If these dates were concluded by EPA to have regulatory significance and concurred to be excluded from regulatory calculations under the EE, then the 24-hour design values as shown in Figure 23 would be updated and reflected in Table 24. Note that Sacramento-Del Paso Manor is the only site with a design value higher than the NAAQS and therefore would be the only site with regulatory significance in this scenario. The annual $PM_{2.5}$ NAAQS is not exceeded with the wildfire impacts included and is, therefore, not included in Table 24.

Table 24 – Concentration analysis for $PM_{2.5}$ monitors serving Sacramento County. **Bold and underlined** numbers exceed the NAAQS[49,50] (source: EPA AQS). Red numbers exclude data under the Exceptional Event Rule[52].

	Three-Year Calculated 24-hr $PM_{2.5}$ Design Value ($\mu g\ m^{-3}$)[c]							
				2018[b]		2019		
Station Name	2015	2016	2017	w/o EE	with EE	w/o EE	with EE	Comparison to NAAQS ($\mu g\ m^{-3}$)[a]
DPM	35	31	34	**37**	31	**37**	32	-3
FOL		20	21	29				
BER						30		-5
SLU*								
TST	30	27	30	34		34		-1
BRU**	28	25	27	27		27		-9

[a] Based on 2019 design values if data was found to have regulatory significance by EPA and excluded under the Exceptional Event Rule.
[b] Dates excluded in 2018 for Del Paso Manor are 11/9-11/15 and 11/20.
* Sloughhouse monitor came online May 2017, therefore there are no valid 3-year design values in the assessment period.
** Elk Grove-Bruceville monitor is non-FEM, therefore design values are not valid, only an estimate for comparison purposes. Data from 11/9/2018 – 11/21/2018 were removed from calculation for BRU due to exceptional impacts from wildfire.

As mentioned previously, the exceedance probability was calculated by applying a bootstrap analysis to the concentration outputs of 2014-2016 source data from the EPA Downscaler Model. Figure 25 shows the $PM_{2.5}$ monitoring stations overlaid on the calculated $PM_{2.5}$ exceedance probability. According to this estimation, Sacramento-Del Paso Manor, Folsom-Natoma St., and Sacramento-Bercut Drive all show exceedance probabilities less than 50%. Sloughhouse shows the highest probability at 75%-90% with Sacramento-1309 T Street estimated at 50%-75%. The exceedance probability presented in Table 23 is calculated for the Thiessen polygon which represents each site. It is unclear whether this analysis takes local seasonal sources of $PM_{2.5}$ such as residential wood burning or wildfire smoke into account or how the interpolation of the probability is distributed throughout the county. Based on local knowledge, violations, and historical conditions, the Sacramento-Del Paso Manor and Sacramento-1309 T Street sites tend to have the greatest chance at exceeding the 24-hour $PM_{2.5}$ NAAQS and would be considered the highest importance.

[52] https://www.epa.gov/air-quality-analysis/treatment-air-quality-data-influenced-exceptional-events-homepage-exceptional

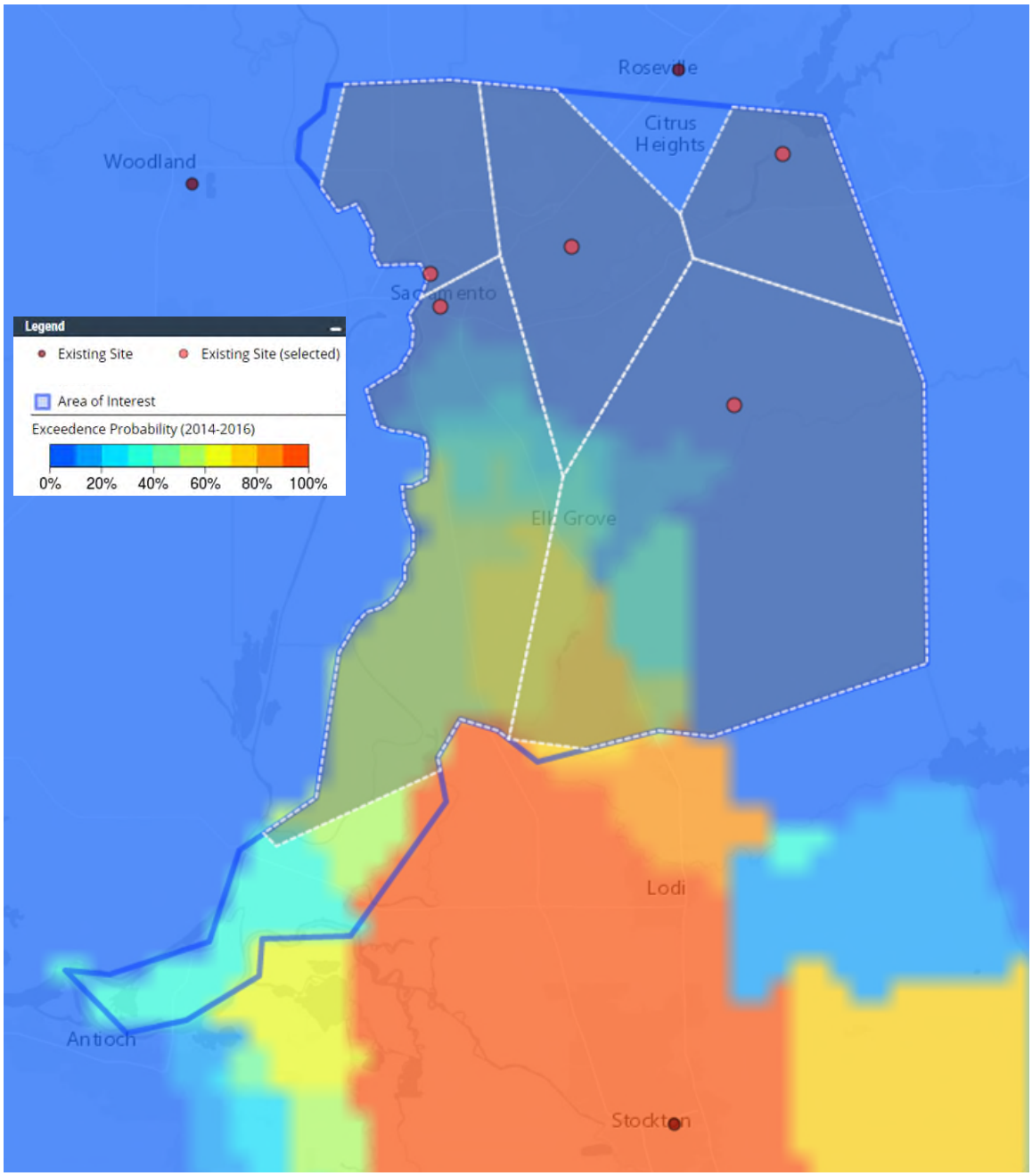


Figure 38 – $PM_{2.5}$ monitoring stations overlaid on the calculated $PM_{2.5}$ exceedance probability (source: NetAssess2020 v1.1).

Table 24 compiles the ranking for the measured concentrations and exceedance probability analyses. As described in the introduction to this document, sites were ranked based on the average concentrations used to determine the design value (DV_{ave}) for the assessment period (2015-2019). The thresholds for this analysis used the 24-hour NAAQS and are as follows:

Monitor Rank	Criteria
High	$DV_{ave} > 35$ µg m^{-3}
Medium	35 µg $m^{-3} \geq DV_{ave} \geq 31.5$ µg m^{-3}
Low	$DV_{ave} < 31.5$ µg m^{-3}

Based on the measured concentrations analysis for $PM_{2.5}$ following these, Sacramento-Del Paso Manor is the only monitor ranked as medium importance and all other monitors are ranked as low importance. For the exceedance probability analysis, based on the NetAssess2020 v1.1 estimation alone, Sloughhouse and Sacramento-1309 T Street are the only sites exceeding 50% probability. It can be inferred from Figure 25 that the non-FEM Elk Grove-Bruceville site would also exceed 50% probability. These three sites are therefore ranked high importance and all other sites ranked low importance for this analysis.

Table 25 – Measured concentrations and exceedance probability ranking.

Station Name	Measured Concentrations	Exceedance Probability*
Sacramento-Del Paso Manor	Medium	Low
Folsom-Natoma St.	Low	Low
Sacramento-Bercut Drive	Low	Low
Sloughhouse	Low	High
Sacramento-1309 T Street	Low	High
Elk Grove-Bruceville**	Low	High

* Based on estimations from the NetAssess2020 v1.1 tool as described in the Sources of Data section.
** Elk Grove-Bruceville monitor is non-FEM and not included in the NetAssess2020 v1.1 tool, rankings are only an estimate for comparison purposes.

Deviation from NAAQS

The thresholds for this analysis, as outlined in the Introduction to this document, use the 24-hour and annual NAAQS and are as follows:

Monitor Rank	Criteria (24-hour)	Criteria (annual)
High	|Deviation| < 3.5 µg m^{-3}	|Deviation| < 1.2 µg m^{-3}
Medium	3.5 µg $m^{-3} \geq$ |Deviation| ≥ 7 µg m^{-3}	1.2 µg $m^{-3} \geq$ |Deviation| ≥ 2.4 µg m^{-3}
Low	|Deviation| > 7 µg m^{-3}	|Deviation| > 2.4 µg m^{-3}

As shown in Table 26, the deviation from NAAQS analysis shows for the 24-hour standard, Sacramento-Del Paso Manor and Sacramento-1309 T Street have the lowest values, or highest ranking based on the thresholds above. Sacramento-Bercut Drive satisfies the criteria for medium importance for both the 24-hour and annual standard and is therefore ranked as such. Sacramento-Del Paso Manor is ranked as medium importance for the annual standard.

Table 26 – 2019 24-hr and annual $PM_{2.5}$ design value and deviation from NAAQS analysis.

Station Name	2019 24-hr $PM_{2.5}$ Design Value ($\mu g\ m^{-3}$)[a]	Deviation from NAAQS ($\mu g\ m^{-3}$)[b]	Ranking
Sacramento-Del Paso Manor	37	2	High
Folsom-Natoma St.			N/A
Sacramento-Bercut Drive	30	5	Medium
Sloughhouse*			N/A
Sacramento-1309 T Street	34	1	High
Elk Grove-Bruceville**	27	9	Low
	2019 Annual $PM_{2.5}$ Design Value ($\mu g\ m^{-3}$)[a]	**Deviation from NAAQS ($\mu g\ m^{-3}$)[b]**	**Ranking**
Sacramento-Del Paso Manor	10.2	1.8	Medium
Folsom-Natoma St.			N/A
Sacramento-Bercut Drive	9.9	2.1	Medium
Sloughhouse*			N/A
Sacramento-1309 T Street	9.4	2.6	Low
Elk Grove-Bruceville**	7.9	4.1	Low

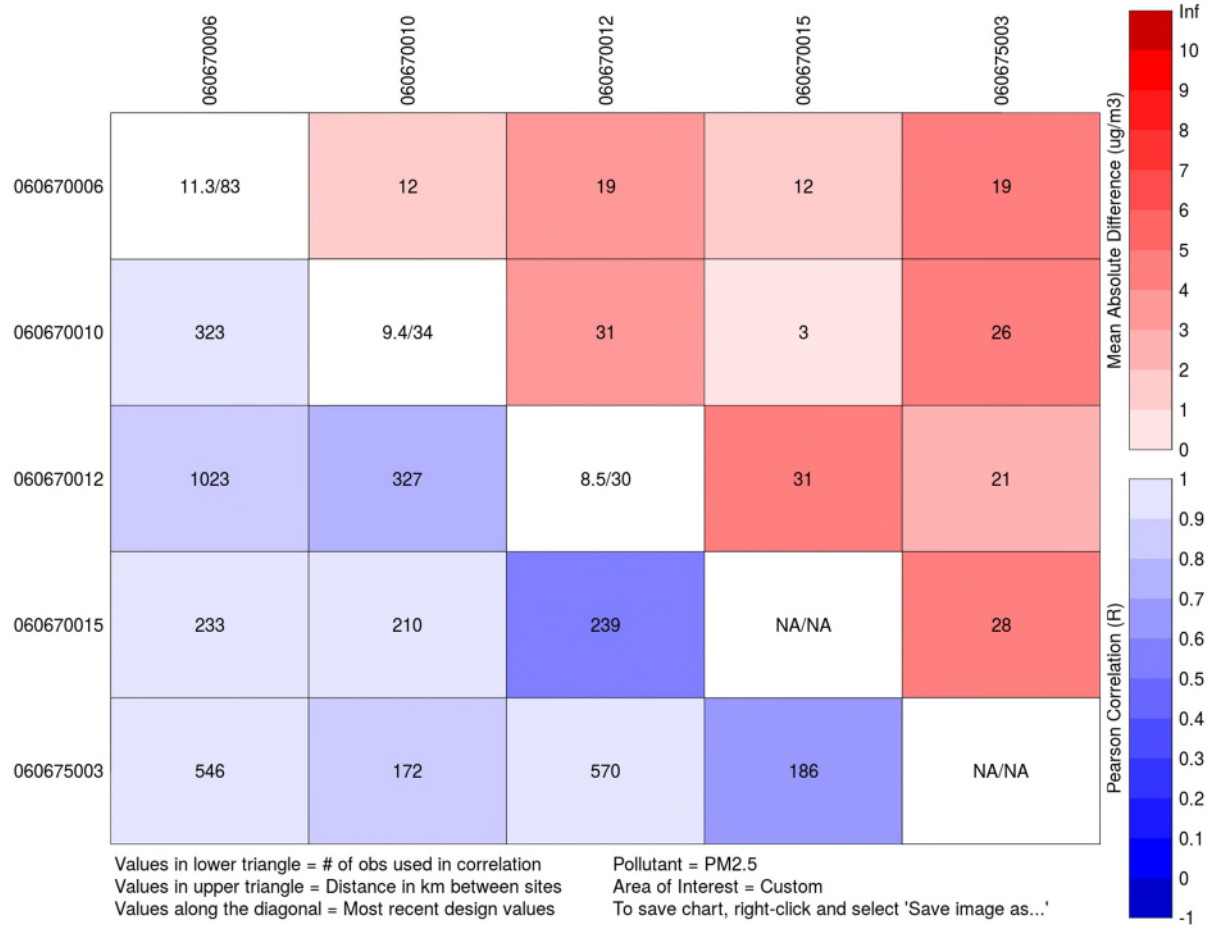
[a] Wildfire smoke in 2018 and 2020 impacted multiple air monitoring stations; the District is working with other monitoring organizations in the Sacramento Federal Non-attainment Area, CARB, and EPA in addressing possible impacts under the Exceptional Event Rule (81 FR 68216).
[b] Based on 2019 design values.
* Sloughhouse monitor came online May 2017, therefore there are no valid 3-year design values in the assessment period.
** Elk Grove-Bruceville monitor is non-FEM, therefore design values are not valid, only an estimate for comparison purposes.

$PM_{2.5}$ Monitor-to-Monitor Correlation Analysis

$PM_{2.5}$ concentrations were compared for redundancy using a correlation matrix analysis. Figure 39 shows a correlation matrix for all $PM_{2.5}$ monitors in Sacramento County provided by the NetAssess2020 v1.1 tool. The raw values from the correlation matrix are shown in Table 27. Included in the matrix are Pearson correlations, mean absolute differences, number of observations used in the correlation, distance in kilometers between the sites, and the 2018 design values. The correlation matrix helps to determine sites within the network that can be considered redundant. Sites with high correlation, low absolute difference, and close proximities are considered redundant in this analysis.

Monitor-to-monitor correlation analysis found that based on the square of the Pearson coefficients (R^2), all five of the monitors within Sacramento County were highly correlated with at least one other monitor based on the Network Assessment Guidance ($R^2 > 0.75$). The high correlation between the sites could be in part due to seasonal and regional-scale factors such as the relatively homogenous terrain throughout the county, widespread wildfire impacts, and consistent meteorological conditions (e.g. wintertime temperature inversions). These high correlations indicate that concentrations tend to fluctuate in unison at each of these sites, however when investigating the mean difference in concentrations, the subtleties of each site become prevalent. For example, Sacramento-Del Paso Manor as mentioned before, is an urban residential site with historically high $PM_{2.5}$ concentrations possibly due to wintertime residential wood burning sources. This site has the largest mean difference (near 5 $\mu g\ m^{-3}$) with Sloughhouse, which is a rural site with much lower population density. Therefore, even though the

$PM_{2.5}$ concentrations are highly correlated, the magnitude of the measured concentrations can vary. This highlights not only the general trends, but localized variability of $PM_{2.5}$ pollution throughout the county. The last factor to include in this analysis is the proximity of the stations to each other. The Sacramento-1309 T Street and Sacramento-Bercut Drive sites are the closest in proximity at only 3 km. Every other site in the network is at least 10 km from each other.



60670006 – Sacramento-Del Paso Manor
60670010 – Sacramento-1309 T Street
60670012 – Folsom-Natoma St.
60670015 – Sacramento-Bercut Drive
60675003 – Sloughhouse

Figure 39 – Correlation matrix for $PM_{2.5}$ monitors serving Sacramento County (source: NetAssess2020 v1.1). The lower triangle refers to the blue shaded boxes and the upper triangle refers to the red shaded boxes. Most recent design values are for the 2018 design value year (annual/24-hour).

Based on thresholds outlined in the Introduction of this document, the criteria for this analysis are as follows:

Monitor Rank	Criteria
High (meets 1 or less of the criteria)	Highest pairwise $R^2 > 0.75$
Medium (meets 2 of the criteria)	Distance between sites < 8 km
Low (meets 3 of the criteria)	Mean Difference < 1.24 µg m^{-3}

Table 27 – Monitor to monitor correlation data. **Red and bold** represent conditions considered to be redundant (R^2 > 0.75, distance between sites < 25% of maximum distance between any two sites, mean difference < 25% of maximum mean difference between any two sites).

Site #1	Site #2	Distance Between Sites (km)	Number of Observations	Pearson Correlation	R^2	Mean Difference (µg m^{-3})
DPM	TST	12	323	0.9581	**0.918**	1.7981
DPM	FOL	19	1023	0.8445	0.713	3.6415
DPM	BER	12	233	0.9312	**0.867**	1.6275
DPM	SLU	19	546	0.9043	**0.818**	4.9689
TST	FOL	31	327	0.7887	0.622	3.4113
TST	BER	**3**	210	0.9898	**0.98**	**0.8262**
TST	SLU	26	172	0.8682	**0.754**	4.4587
FOL	BER	31	239	0.551	0.304	4.0828
FOL	SLU	21	570	0.9182	**0.843**	2.8386
BER	SLU	28	186	0.6728	0.453	4.786

DPM – Sacramento-Del Paso Manor
TST – Sacramento-1309 T Street
FOL – Folsom-Natoma St
BER – Sacramento-Bercut Drive
SLU – Sloughhouse

This monitor-to-monitor correlation analysis shows that the Sacramento-Bercut Drive and Sacramento-1309 T Street $PM_{2.5}$ sites can be considered redundant (rank low) as they meet all three criteria. The Sacramento-Bercut Drive monitor is required as part of the Near Road network and unsuitable for removal. All other sites meet one or less of the criteria and are therefore ranked as high importance for this analysis. The Elk-Grove Bruceville site was not included in this analysis as it operates a non-FEM monitor. The rankings for this analysis are summarized in Table 28.

Table 28 – Monitor-to-monitor correlation ranking.

Station Name	Monitor-to-Monitor Rank
Sacramento-Del Paso Manor	High
Folsom-Natoma St.	High
Sacramento-Bercut Drive	Low
Sloughhouse	High
Sacramento-1309 T Street	Low
Elk Grove-Bruceville*	N/A

* This $PM_{2.5}$ monitor is not comparable to NAAQS because it does not meet reference method or equivalent method designation requirements

Trend Analysis

Monitors that have a long historical record are valuable for tracking trends. In this analysis, sites are ranked based on the duration of the continuous measurement record as described in the Introduction to this document. The thresholds for this analysis are as follows:

Monitor Rank	Criteria
High	Trend ≥ 23 years
Medium	23 years > Trend ≥ 8 years
Low	Trend < 8 years

Table 29 shows the year that $PM_{2.5}$ measurements began at each of the stations serving Sacramento County. Based on this analysis, Sacramento-Del Paso Manor is ranked as high importance, followed by Sacramento-1309 T Street and Elk Grove-Bruceville ranked as medium importance.

Table 29 – Date of operation for each $PM_{2.5}$ station serving Sacramento County.

Station Name	Begin Year of $PM_{2.5}$ Operation	Trend Rank
Sacramento-Del Paso Manor	1990	High
Folsom-Natoma St.	2013	Low
Sacramento-Bercut Drive	2016	Low
Sloughhouse	2017	Low
Sacramento-1309 T Street	1998	Medium
Elk Grove-Bruceville*	2003	Medium

* This $PM_{2.5}$ monitor is not comparable to NAAQS because it does not meet reference method or equivalent method designation requirements

$PM_{2.5}$ Monitor Removal Bias Analysis

Each monitor was analyzed to determine the change in spatial concentrations interpolated across Sacramento County if the monitor was removed. Table 30 and Figure 40 present the results of the removal bias analysis and the maximum change in $PM_{2.5}$ concentrations in Sacramento County if each $PM_{2.5}$ monitor in the District's network was individually removed as calculated by the NetAssess2020 v1.1 tool.

The change in concentration at a site indicates the bias which may be observed if the individual monitor were removed. Per the Network Assessment Guidance, "[t]he greater the bias, the more important the site is for interpolation." Based on the thresholds outlined in the Introduction to this document, the thresholds for this analysis are as follows, where MRB is the mean relative bias:

Monitor Rank	Criteria
High	$\lvert MRB \rvert \geq 0.945\ \mu g\ m^{-3}$
Medium	$0.945\ \mu g\ m^{-3} > \lvert MRB \rvert \geq 0.315\ \mu g\ m^{-3}$
Low	$\lvert MRB \rvert < 0.315\ \mu g\ m^{-3}$

Table 30 below indicates that removal of the Sacramento-Del Paso Manor $PM_{2.5}$ monitor could introduce a significant bias (-1.26 $\mu g\ m^{-3}$) in concentration interpolation. All other stations are less than 1 $\mu g\ m^{-3}$, however the lowest bias is Sacramento-Bercut Drive at 0.45 $\mu g\ m^{-3}$ which is still significant considering how close the Sacramento nonattainment area is to the 24-hr standard. Therefore, based on the thresholds outlined in the Introduction to this document, the Sacramento-Del Paso Manor $PM_{2.5}$

monitor is ranked as the highest importance and all other stations are ranked as medium importance (see Table 31). Note that even though the Sacramento-Bercut Drive site has the lowest rank in this analysis, the site is part of the Near Road network and is required in the Sacramento Metro area.

Table 30 – $PM_{2.5}$ monitoring network removal bias results.

Station Name	Mean Removal Bias ($\mu g\ m^{-3}$)
Sacramento-Del Paso Manor	-1.26
Folsom-Natoma St.	0.6
Sacramento-Bercut Drive	0.45
Sloughhouse	-0.8
Sacramento-1309 T Street	0.91

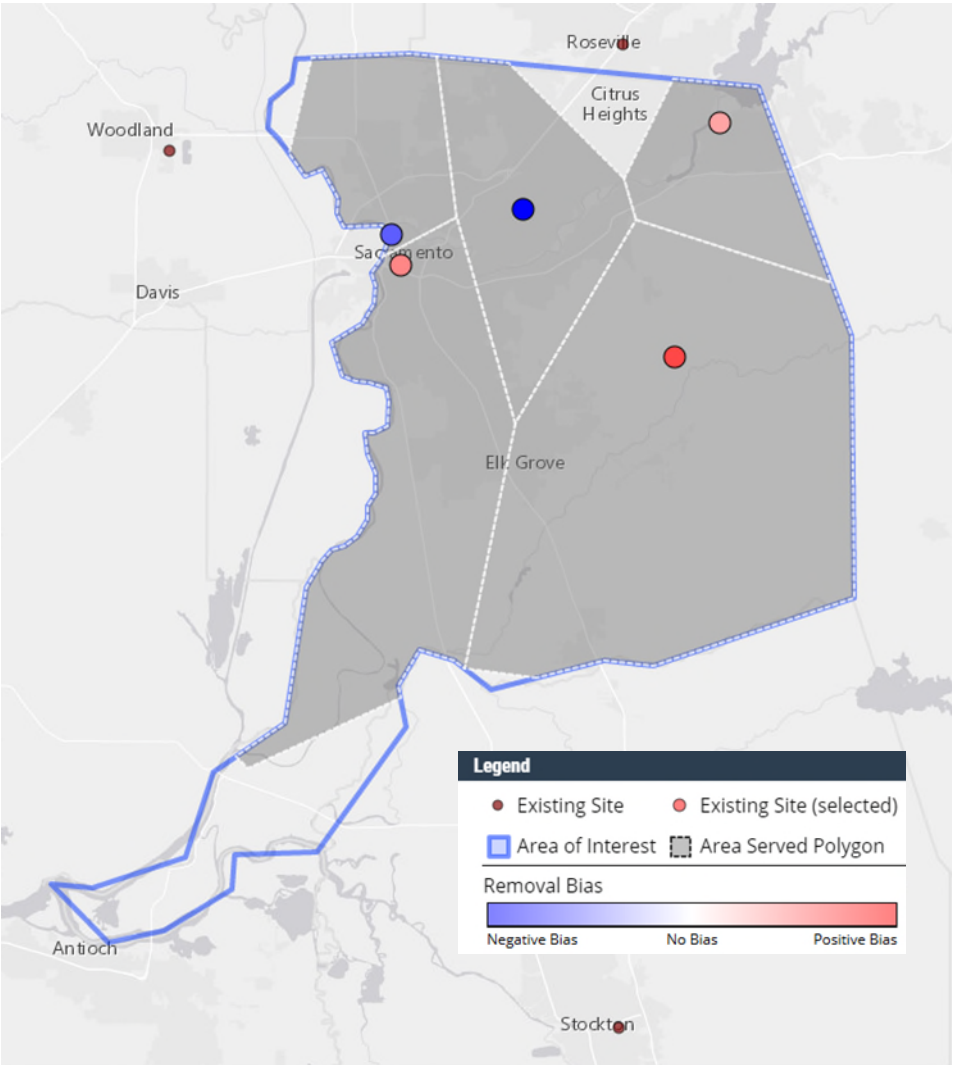


Figure 40 – $PM_{2.5}$ Removal bias analysis in Sacramento County.

Table 31 – Removal bias rank

Station Name	Removal Bias Rank
Sacramento-Del Paso Manor	High
Folsom-Natoma St.	Medium
Sacramento-Bercut Drive	Medium
Sloughhouse	Medium
Sacramento-1309 T Street	Medium

$PM_{2.5}$ Minimum Number of Monitors Required

The minimum number of monitors required under Appendix D of 40 CFR Part 58 and number of sites in the Sacramento MSA are listed in Table 32. Note that there are six (6) sites in Sacramento County as shown in Figure 30, and eight (8) sites within Sacramento MSA. CBSAs with a population above 1,000,000 and the most recent three-year design value above 85% of the $PM_{2.5}$ NAAQS must have a minimum of three active $PM_{2.5}$ monitors. The District currently has six (6) active stations sampling $PM_{2.5}$ (BER, BRU, DPM, FOL, SLU, TST). Three of the stations have active $PM_{2.5}$ FRM monitors (DPM, BER, TST), two stations have FEM-designated continuous $PM_{2.5}$ monitors (FOL, SLU), and three stations have non-FEM-designated continuous $PM_{2.5}$ monitors (BRU, DPM, TST) whose data are used for public information and research purposes.

Table 32 – Minimum monitoring requirements within Sacramento MSA.

	Sites Required	Sites in Sacramento MSA	Additional Sites Needed	2019 Design Value and Site ID*
FEM/FRM	3	8	0	**24-hr standard:** (1) 54 µg m^{-3} at Woodland (06-113-1003) (2) 34 µg m^{-3} at Sacramento-1309 T Street (06-067-0006) **Annual standard:** (06)10.2 µg m^{-3} at Sacramento-Del Paso Manor (06-067-0006) (2) 9.3 µg m^{-3} at Sacramento-Del Paso Manor (06-067-0006)
Continuous	2	8	0	

* The Sacramento Valley was impacted by a number of wildfires in 2018; the design values are noted with (1) include all data collected in 2018 and (2) exclude data with wildfire impacted data as outline in the exception event demonstration package the District submitted to U.S. EPA.

Additional Information for Consideration

As mentioned in this section, the design value for Sacramento is close to the NAAQS for the 24-hour standard. The wintertime concentrations can be elevated due to meteorological conditions such as temperature inversions and increased residential wood burning. The summertime concentrations are

also elevated as wildfires become more common throughout California and the western United States. Throughout the year, there are periods of elevated particulate matter which require accurate and spatial measurements for public notification throughout the county. This commitment to public notification and health is demonstrated in the District's various programs including the Community Air Protection program (CAPP), Wildfire Smoke Air Pollution Emergency Plan, residential woodsmoke curtailment program, and dedication to providing materials and education to aid communities in making healthy decisions. These programs provide important $PM_{2.5}$ data throughout the portions of Sacramento County where there either currently is no, or it is unfeasible to install, air monitoring stations. Often this data can be high resolution both spatially and temporally and provide important information, even though the sensors are not applicable for regulatory purposes or comparisons. This network of sensors includes portions of, or communities within, the county that tend to show disparities in environmental justice. More details on the technological aspect of the network are included in the Future Priorities and Technologies section.

The importance of these programs are highlighted in Figure 41, which shows the District regulatory $PM_{2.5}$ air monitoring stations and the Phase I and Phase II $PM_{2.5}$ air monitoring stations from the CAPP (AB 617) overlaid on the 2020 total population by census tract and population change in Sacramento County census tracts from 2010-2020 from the United States Census Bureau decennial 2020 census data layers for 2020 Public Law 94-171 (P.L. 94-171). There is growth exceeding the 90^{th} percentile for population change in some of the more populated areas in the southern portion of the county (e.g. communities of Vineyard and Elk Grove). These areas are between the Sacramento-T Street and Elk Grove-Bruceville air monitoring stations, precisely where the CAPP monitors are located. As the population in Sacramento County expands south, there will be continued evaluation of need to provide localized measurements for public information to the residents in these communities.

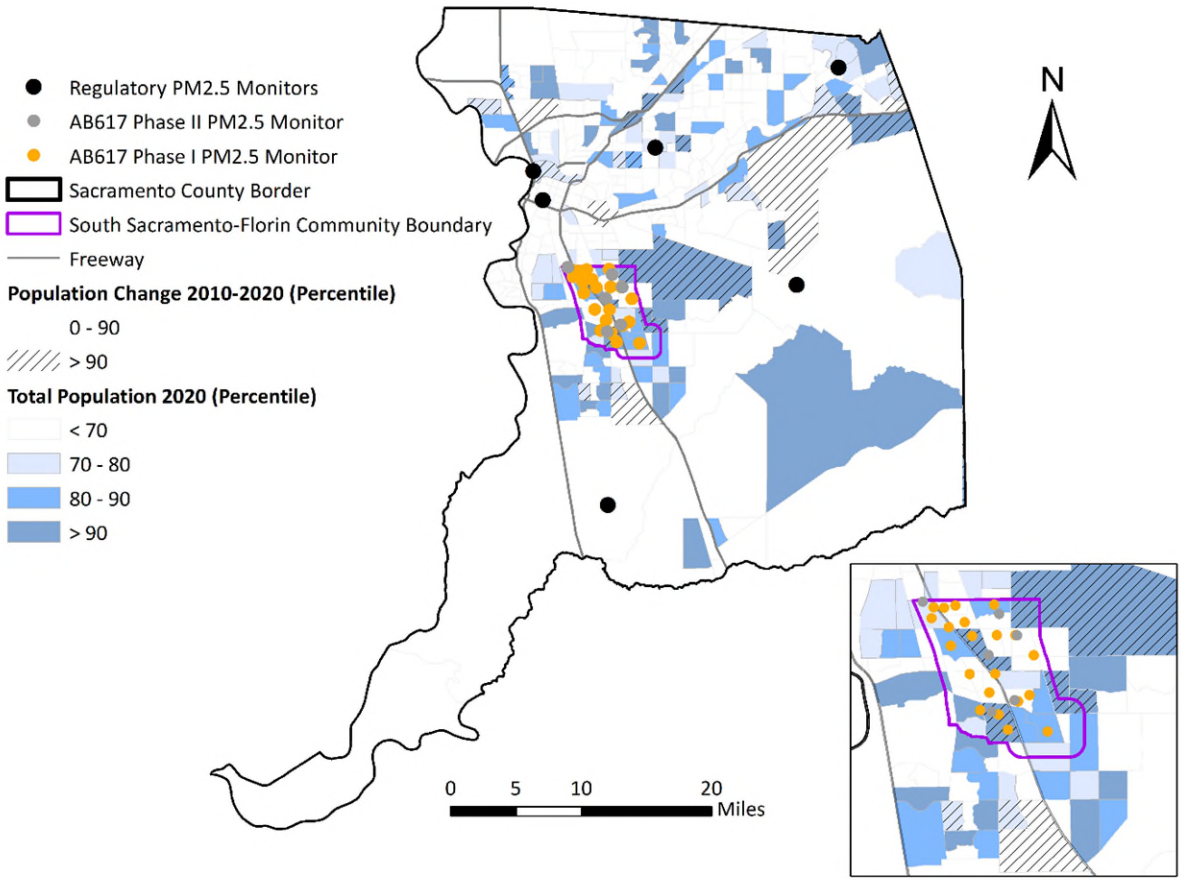


Figure 41 – Regulatory (black dots) and Community Air Protection program (AB 617; orange and gray dots) $PM_{2.5}$ monitors within Sacramento County. The purple line indicates the South Sacramento-Florin community boundary. Blue shading indicates 2020 U.S. Census total population in percentile by census tract. Black hatching indicates greater than the 90th percentile of population change from the 2010 to 2020 decennial censuses (source: United States Census Bureau). Inset is a more detailed view of the South Sacramento-Florin community and surrounding area.

The high-resolution network of CAPP portable sensors is currently being evaluated with regulatory-grade sensors to test reliability, precision, and accuracy. These sensors may provide valuable information from within these communities and help to inform the District on future $PM_{2.5}$ monitoring locations. However, as seen in Figure 42, preliminary time series analysis of portable sensor $PM_{2.5}$ data shows that $PM_{2.5}$ concentrations from the CAPP community are comparable to those at the Sacramento-Del Paso Manor site which has similar community characteristics with similar emission sources (e.g., residential wood burning, traffic-related particulate matter). This is consistent with the 2015 Air Monitoring Network Assessment which states that "[Sacramento-]T Street and [Sacramento-]Del Paso Manor collect air quality data representative of more congruent urbanized areas near Vineyard and Elk

Grove."[53] Therefore, based on PM2.5 monitoring requirements concurrent with Appendix D of 40 CFR Part 58 as well as information described in this section, no new $PM_{2.5}$ air monitoring stations are recommended at this time.

[53] 2015 Air Monitoring Network Assessment, Sacramento Metropolitan Air Quality Management District, 2016. http://www.airquality.org/ProgramCoordination/Documents/2015%20Air%20Monitoring%20Network%20Assessment.pdf.

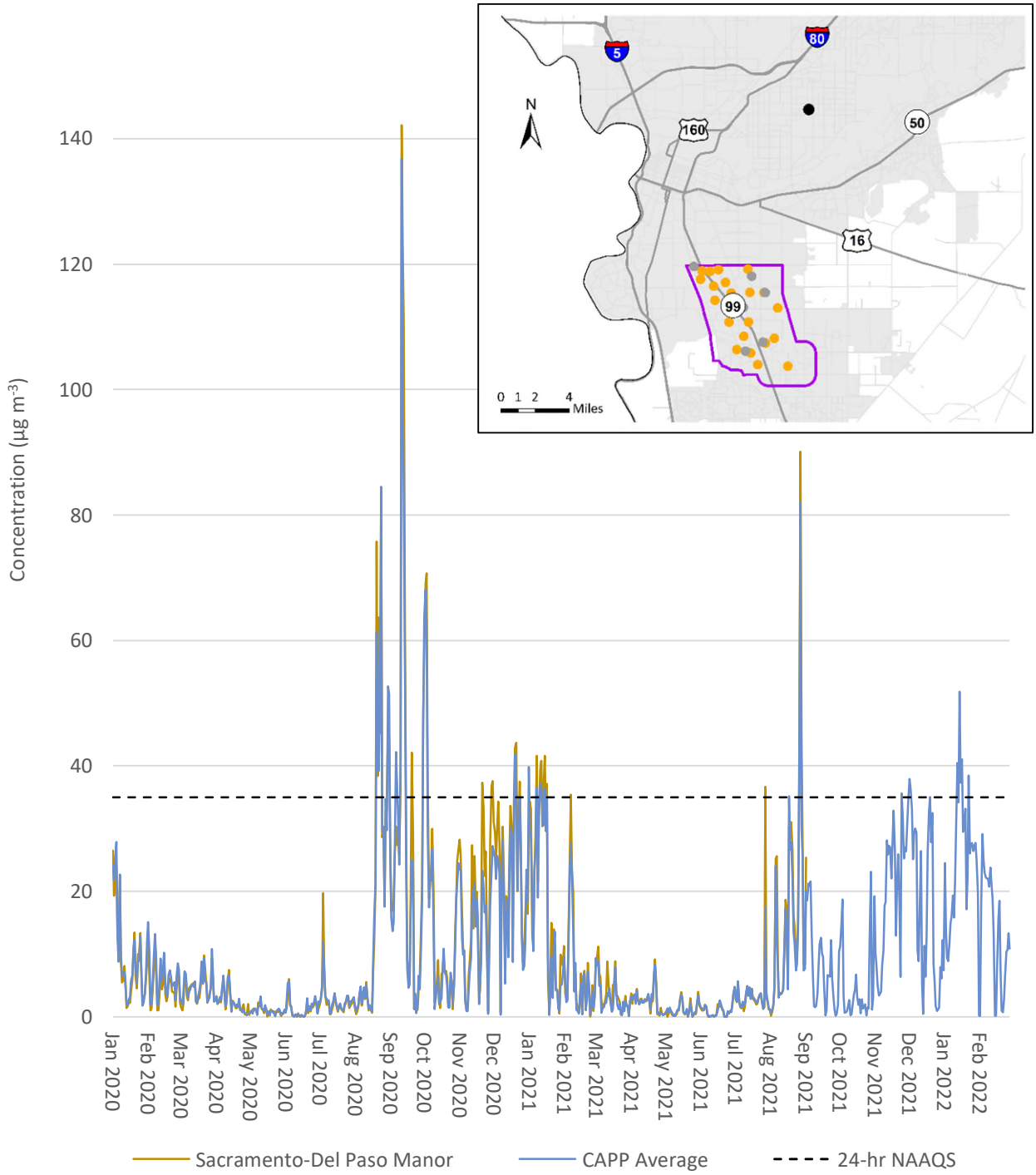


Figure 42 – Timeseries analysis of portable $PM_{2.5}$ sensor concentrations for the Community Air Protection program (CAPP) community average of 21 sensors and the Sacramento-Del Paso Manor site. The black dashed line indicates the 24-hr $PM_{2.5}$ NAAQS. Note that wildfire smoke impacted the concentrations during August-October 2020 and July-October 2021. The inset shows a map of the Sacramento-Del Paso Manor site (black dot), CAPP $PM_{2.5}$ monitors within Sacramento County (orange and gray dots), and the South Sacramento-Florin community boundary (purple line).

Conclusions

Table 33 is a summary of the District's $PM_{2.5}$ monitor rankings from the analyses performed in this section. An overall ranking was calculated for each site by assigning a value to each rank (1 – low, 2 – medium, 3 – high) and summing over all analyses.

Table 33 – $PM_{2.5}$ monitor ranking summary. Overall score is shaded red, with highest overall score darkest.

Station Name	Population-Served	Area-Served	Measured Concentrations	Exceedance Probability[a]	Deviation from NAAQS 24-hour	Deviation from NAAQS Annual	Monitor-to-Monitor	Trend	Removal Bias	Overall
DPM	High	Medium	Medium	Medium	High	Medium	High	High	High	23
FOL	Low	Low	Low	Low	N/A	N/A	High	Low	Medium	10
BER	Low	Low	Low	Low	Medium	Medium	Low	Low	Medium	12
SLU	Low	High	Low	High	N/A	N/A	High	Low	Medium	14
TST	High	Low	Low	High	High	Low	Low	Medium	Medium	17
BRU	Medium	High	Low	High	Low	Low	N/A	Medium	N/A	13

[a] Based on estimations from the NetAssess2020 v1.1 tool as described in the Sources of Data section.

Based on Table 33, the Sacramento-Del Paso Manor and Sacramento-1309 T Street sites are the highest overall ranked and therefore most important sites for $PM_{2.5}$. Folsom-Natoma St. is ranked the lowest of the sites. Note that Elk Grove-Bruceville is operating a non-FEM monitor, and this site is not included in some of the analyses, therefore lowering its possible total. Also, Folsom-Natoma St. and Sloughhouse did not have a valid design value to compare to the NAAQS in the deviation from the NAAQS analysis, therefore lowering their possible scores too.

As mentioned in this section, the design value for Sacramento is close to the NAAQS for the 24-hour standard. Wintertime and summertime concentrations can both be elevated due to different particulate matter sources (e.g. residential wood burning and wildfire smoke). The District prioritizes a commitment to public notification and health. This is demonstrated through the District's various programs including the Community Air Protection program (CAPP), Wildfire Smoke Air Pollution Emergency Plan, residential woodsmoke curtailment program, and dedication to providing materials and education to aid communities in making healthy decisions. The District continues to evaluate data provided from these programs to help meet the needs of the residents of Sacramento County as well as District priorities. Current analyses show that no new $PM_{2.5}$ sites are required, however the District is dedicated to evaluating as many factors as possible to provide the most robust $PM_{2.5}$ monitoring network as possible.

Some of the current air monitoring sites are included in various EPA monitoring programs (e.g. Near Road and NCore) and are not suitable for removal. Currently, the District network adequately meets all EPA monitoring requirements and covers various particulate matter monitoring purposes consistent with District monitoring goals and objectives.

In conclusion, the current $PM_{2.5}$ network for Sacramento County meets all federal requirements and adequately meets District monitoring objectives. There are no sites in Sacramento County recommended for removal.

Coarse Particulate Matter (PM_{10}) Network Analysis

Monitoring Objectives

Sacramento County has a total of three (3) active SLAMS PM_{10} monitoring stations as shown in Figure 43. The North Highlands-Blackfoot station as discussed in the Recent Notable Modifications to the Network section was discontinued after the assessment period. Based on the characteristics of the sites, including the population served and the area served, each site can be designated as background, population oriented, or high concentration monitoring locations as depicted in Table 21. The Sacramento-1309 T Street site operates an hourly PM_{10} monitor, all other sites operate 24-hour monitors. Three PM_{10} monitors are operated at the Sacramento-Del Paso Manor monitoring site; the primary monitor for NAAQS comparison and its collocated (audit) monitor (AQS[54] parameter code 88102), and a PM_{10} monitor used in the calculation of particulate matter with diameter between 10 and 2.5 micrometers ($PM_{10\text{-}2.5}$; AQS parameter code 85101). The primary and $PM_{10\text{-}2.5}$ monitors are requirements of the NCore monitoring network as outlined in 40 CFR Appendix D to Part 58. Appendix A to 40 CFR 58 details requirements for the collocated monitor within the CARB primary quality assurance organization (PQAO). This assessment will use data from the primary monitor.

[54] EPA Air Quality System; https://www.epa.gov/aqs.

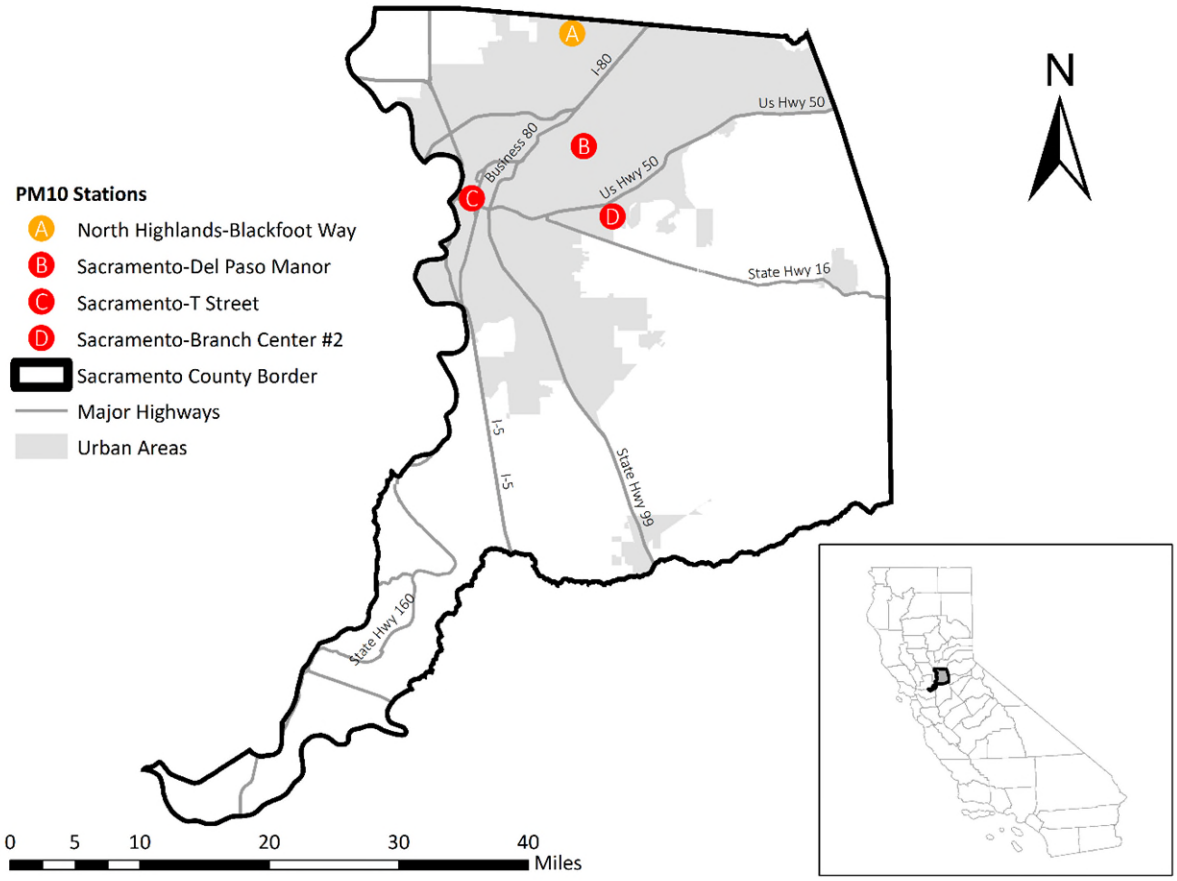


Figure 43 – PM_{10} Network in Sacramento County. Red markers indicate active monitors. Orange marker indicates an active monitor during the assessment period but is no longer active.

Table 34 – Monitoring type for PM_{10} monitors serving Sacramento County.

Site	EPA Network Affiliation*	Monitoring Type**
North Highlands-Blackfoot		Population Oriented
Sacramento-Del Paso Manor	NCORE	Population Oriented
Sacramento-1309 T Street		Population Oriented
Sacramento-Branch Center #2		High Concentration

Note: All monitors are SLAMS (State and Local Air Monitoring Stations) monitor type unless otherwise noted.
* NCORE (National Core Multi-pollutant Monitoring Stations), SPM (Special Purpose Monitor not part of SLAMS).
** Consistent with EPA monitoring types as listed in 40 CFR Part 58, Appendix D.

In 1987, EPA set the NAAQS for coarse particulate matter (PM_{10}) at a level of 150 µg/m³. The design value is the 24-hour average not to be exceeded more than once per year on average over 3 years. On January 20, 1994, Sacramento County was classified as a "moderate" nonattainment area for the 24-hour PM_{10} NAAQS (58 FR 67334). Sacramento County attained the standard based on PM_{10} air quality

monitoring data from 1998 to 2000 (67 FR 7082). The District has prepared a Second 10-year Maintenance Plan for Sacramento County that shows maintenance of the 24-hour PM_{10} NAAQS from 2024 through 2033[55]. The plan includes updated emission inventories, demonstrates maintenance of the PM_{10} standard, provides an updated control measure evaluation, and establishes new motor vehicle emissions budgets.

Sacramento County has seen comparable or decreases in PM_{10} concentrations since the previous assessment, which is a result of implemented control measures. However, in 2017, 2018, and 2019, the county recorded peak PM_{10} concentrations near or above the standard of 150 µg m^{-3}. These peak concentrations, between 2017 and 2019, were all impacted by wildfires and/or high wind dust events. Table 35 shows the maximum concentrations by site and the number of days exceeding the 24-hour NAAQS. The values in parentheses correspond to the maximum value after excluding the flagged data as exceptional[56] in EPA AQS and in accordance with 81 FR 68216, Treatment of Data Influenced by Exceptional Events.

Table 35 – PM_{10} maximum 24-hour average concentrations (µg m^{-3}) and number of exceedance days for the 24-hour NAAQS for Sacramento County monitoring sites (Concentration where exceptional event data are excluded from calculation in parentheses; bold and underlined exceed the 24-hr NAAQS) (source: EPA AQS).

	Maximum 24-hour PM_{10} Concentration (µg m^{-3})				
Year	**NH**	**DPM**	**TST**	**BC**	**Maximum**
2015	45	40	57	44	57
2016	31	31	49	45	49
2017	66	57	149	79	149
2018	**222** (50)	**212** (42)	**292** (147)	**200** (65)	**292** (147)
2019	53	53	**174**	53	**174**
	Days Exceeding the 24-hour NAAQS of 150 µg m^{-3}				
Year	**NH**	**DPM**	**TST***	**BC**	**All Sites**
2015	0	0	0	0	0
2016	0	0	0	0	0
2017	0	0	0	0	0
2018	2 (0)	2 (0)	6 (0)	1 (0)	11 (0)
2019	0	0	1	0	1

* T Street operates a FEM continuous PM10 sampler, all other sites operate FRM filter-based 1 in 6-day samplers.
NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor, POC 1
TST – Sacramento-1309 T Street
BC – Sacramento-Branch Center #2

From 2017 to 2019, Sacramento County observed outlier spike concentrations in the peak 24-hour PM_{10} concentrations, which are influenced by wildfires and/or high wind dust events. The peak 24-hour PM_{10} concentration in 2017 was 149 µg m^{-3} on October 8 at the Sacramento T-Street monitoring station. This peak concentration was suspected to be impacted by wildfire smoke and a high wind dust event.

[55] Second 10-Year PM_{10} Maintenance Plan for Sacramento County; https://www.airquality.org/air-quality-health/air-quality-plans/federal-planning
[56] Data flagged in EPA AQS as qualifier code: RT (Wildfire-U.S.), qualifier type: Request Exclusion.

Sacramento County experienced many days in 2018 where the PM_{10} concentrations were impacted and elevated by wildfire smoke. These high concentrations were recorded during November 2018 and were impacted by the smoke from the Camp Fire Wildfire (see $PM_{2.5}$ section of this assessment for additional details). The top six highest PM_{10} concentrations were above the PM_{10} NAAQS and were included in an Exceptional Event Demonstration for November 2018 PM_{10} Exceedances in Sacramento County Due to Wildfires[57]. Table 36 shows the top fourteen PM_{10} concentrations sampled in 2018. Thirteen days of the highest PM_{10} concentrations occurred on consecutive days from November 8 to 20 in 2018, which was during the Camp Fire Wildfire. These exceptional concentrations are valuable in understanding the PM_{10} pollution that impacted Sacramento County during the assessment period. Throughout this section, the PM_{10} network analysis was performed before EPA concurrence of the November 2018 Wildfire Exceptional Event demonstration. Therefore, the PM10 network was analyzed as if these days may be subject to the Exceptional Event Rule (81 FR 68216) and pending EPA approval and could be removed from regulatory decisions. For some analyses such as measured concentration or deviation from the NAAQS, data is presented with and without these dates included in the calculations. To assess the network under typical conditions, site ranking is based on data with these dates removed from the calculations.

Table 36 – Top PM_{10} 24-hour average concentrations in 2018, sorted from highest to lowest concentration. **Bold and underlined** exceed the 24-hour PM_{10} NAAQS (source: EPA AQS).

Date	24-hour Concentration ($\mu g\ m^{-3}$)	Monitoring Station	Notes
11/15/2018	**292**	TST	Requested in the Exceptional Event Demonstration to be excluded from regulatory decisions
11/16/2018	**252**	TST	
11/10/2018	**222**	NH	
11/12/2018	**183**	TST	
11/14/2018	**181**	TST	
11/11/2018	**176**	TST	
11/13/2018	147	TST	Most likely impacted by Camp Fire Wildfire
11/17/2018	145	TST	
11/18/2018	134	TST	
11/19/2018	130	TST	
11/20/2018	108	TST	
11/08/2018	94	TST	May be impacted due to the start of the Camp Fire Wildfire
11/09/2018	83	TST	
05/11/2018	79	TST	

NH – North Highlands-Blackfoot
TST – Sacramento-1309 T Street

[57] The District's "Exceptional Event Demonstration for November 2018 PM_{10} Exceedances in Sacramento County Due to Wildfires" has been concurred by EPA via letter on July 27, 2022.

An exceedance of the PM_{10} standard also occurred at the Sacramento T-Street monitoring station on October 27, 2019. The 24-hour concentration was 174 µg/m^3 and was the peak concentration in 2019. A preliminary review showed it may be caused by wildfire smoke and a high wind dust event.

As mentioned in the $PM_{2.5}$ section of this assessment, climate change has increased the frequency, duration, and magnitude of wildfires throughout the western United States thus impacting particulate matter concentrations in Sacramento County. Climate change has also increased the magnitude of severe weather events, including high wind events and drought conditions. These conditions are particularly impactful to Sacramento County due to the proximity to agricultural operations. All of these factors in one combination or another are common impacts during PM_{10} exceedances.

PM_{10} Network Area- and Population-Served Analyses

Spatial analysis techniques were evaluated to determine whether the current PM_{10} stations meet the objectives of the monitoring network. Thiessen polygons, as described in the Sources of Data section, were generated by the NetAssess2020 v1.1 tool to determine the spatial representation of each of the four (4) PM_{10} monitoring stations located in Sacramento County. The following sections present the findings for area- and population-served analyses for the PM_{10} network. Note that as seen in Table 34, some of the PM_{10} stations are affiliated with EPA networks and are therefore required regardless of these analyses.

The population within Sacramento County represented by each monitoring site was counted within the Thiessen polygons by NetAssess2020 v1.1 using 2010 US Census data. Area- and population-served analyses are presented in

Table 37. Figure 44 presents a map showing the location and area of influence for each PM_{10} monitor.

Following the methods outlined in the Introduction of this document, Sacramento-Branch Center #2 was found to be the most important PM_{10} site based solely on an area of influence exceeding 500 km^2. All other sites serve much smaller areas that do not exceed the 250 km^2 threshold and are therefore ranked as low importance. Sacramento-1309 T Street and Sacramento-Branch Center #2 serve the most populous portions of Sacramento County exceeding the 317,000 persons threshold and are therefore both deemed important and rank as high in this analysis. The Sacramento-Del Paso Manor site exceeds 159,000 persons and is therefore ranked as medium importance for this analysis. North Highlands-Blackfoot is ranked as low at less than 159,000 persons. The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 37. No changes to the rankings were observed. Site rankings are summarized in

Table 37.

Table 37 – Area and population served by PM_{10} monitors serving Sacramento County. Darker red indicates the highest values and therefore the most importance.

Station Name	Population Estimate (persons)*	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
North Highlands-Blackfoot	151,035	118	Low	Low
Sacramento-Del Paso Manor	202,059	115	Medium	Low
Sacramento-1309 T Street	399,725	206	High	Low
Sacramento-Branch Center #2	345,296	1376	High	High

North Highlands-Blackfoot Removed from Analysis

Station Name	Population Estimate (persons)*	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
Sacramento-Del Paso Manor	316071	212	Medium	Low
Sacramento-1309 T Street	404220	213	High	Low
Sacramento-Branch Center #2	345296	1376	High	High

* Population and area estimates based on monitor's area of influence and an approximate boundary of Sacramento County as extracted from the NetAssess2020 v1.1 tool. Population estimated with some overlapping census tracts.

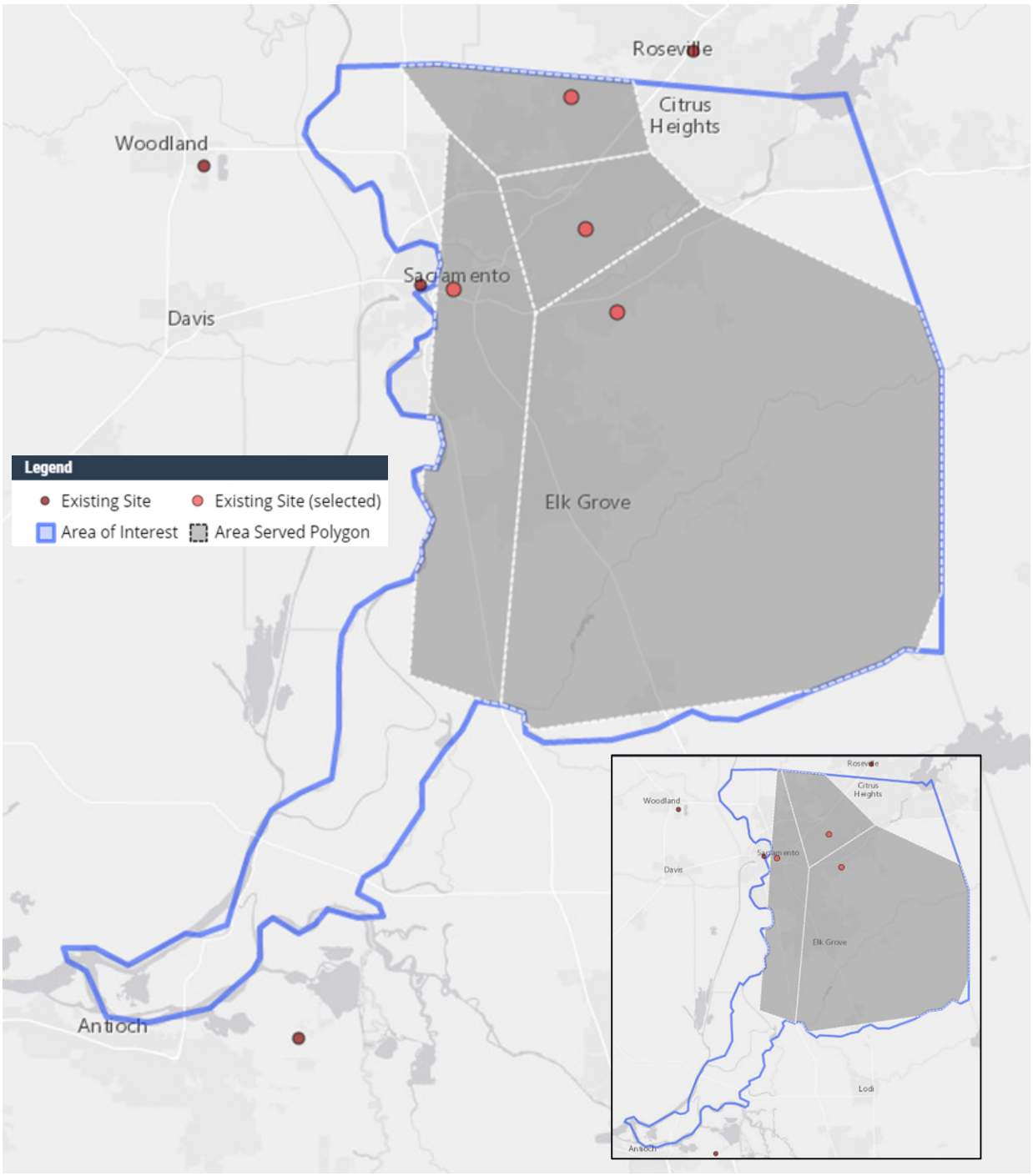


Figure 44 – PM_{10} Network Area-Served analysis. Inset shows analysis with the North Highlands-Blackfoot station removed.

PM_{10} Data Analyses

The PM_{10} data analysis conducted was used to determine the importance of a site based on the following methods:

- measured concentrations and exceedance probability,
- deviation from NAAQS,
- monitor-to-monitor correlation,
- trend impact, and
- removal bias.

Measured Concentration and Exceedance Probability

Monitors within the District's ambient air monitoring network shown to have high levels of PM_{10}, design values close to the standard, and with long historical record were considered to be of high value for characterizing pollution in an area. Table 38 presents 24-hour PM_{10} design value for 2015 through 2019. Estimated exceedances used in the design value calculations are adjusted for 1-in-6 day sampling as per 40 CFR Appendix K to Part 50. The estimated number of exceedances for the year is the sum of the estimates for each calendar quarter rounded to one decimal. The exceedance probability was not calculated in the NetAssess2020 v1.1 tool and is, therefore, not included in this analysis.

Table 38 – Exceedance analysis for PM_{10} monitors serving Sacramento County. Exceptional Event data excluded from calculation in parentheses (EPA AQS qualifier code: RT), **bold and underlined** numbers exceed the NAAQS[58]. Units are estimated number of exceedances (ene) (source: EPA AQS).

Station Name	Annual Estimated Exceedances					Three-Year Calculated 24-hr PM_{10} Design Value (ene)				
	2015	2016	2017	2018	2019	2015	2016	2017	2018*	2019
NH	0	0	0	12.3 (0)	0	0	0	0	**4.1** (0)	**4.1** (0)
DPM	0	0	0	12.3 (0)	0	0	0	0	**4.1** (0)	**4.1** (0)
TST	0	0	0	6 (0)	1	0	0	0	**2** (0)	**2.3** (0.3)
BC	0	0	0	6.1 (0)	0	0	0	0	**2** (0)	**2** (0)

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor
TST – Sacramento-1309 T Street
BC – Sacramento-Branch Center #2

* Wildfire smoke in 2018 impacted multiple air monitoring stations; the District is working with other monitoring organizations in the Sacramento Federal Non-attainment Area, CARB, and EPA in addressing possible impacts under the Exceptional Event Rule (81 FR 68216).

[58] The 24-hour design value of 150 µg m^{-3} is not to be exceeded more than once per year on average over a 3-year period, EPA, https://www.epa.gov/pm-pollution/timeline-particulate-matter-pm-national-ambient-air-quality-standards-naaqs.

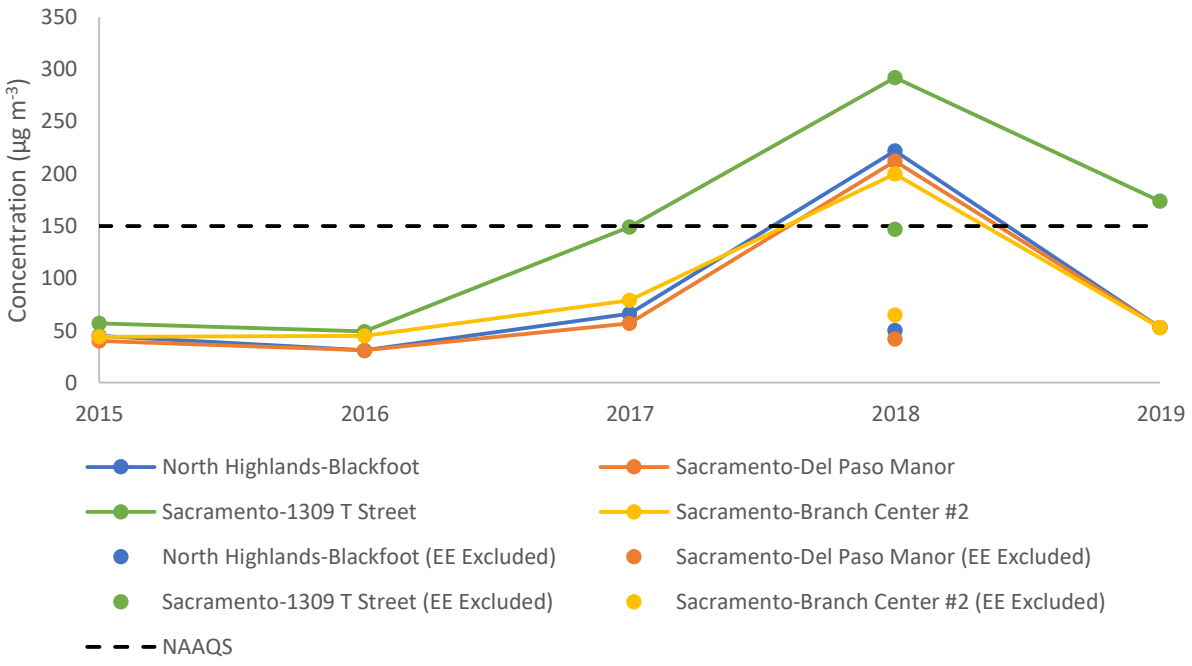


Figure 45 – Maximum 24-hour PM_{10} concentration trend with and without Exceptional Event data excluded from calculations (Source: EPA AQS).

Figure 45 presents the 2015 through 2019 maximum 24-hour concentrations with and without data flagged as exceptional for PM_{10} monitors serving Sacramento County. As described in the EPA network assessment guidance (EPA, 2007), "[m]onitors that measure high concentrations or design values are ranked higher than monitors that measure low concentrations." Therefore, for PM_{10}, sites that exceed the 150 µg m^{-3} 24-hour standard are ranked as high importance, sites that are within 10 µg m^{-3} of the standard are ranked as medium importance, and other sites are ranked as low importance. Based on the data shown in Figure 45 and Table 35, all of the sites sampled higher than the standard during the assessment period. These exceedances took place mainly during wildfire or high dust events, which are occurring more and more frequently in the western United States due to climate change as described earlier in the Natural Event Impacts on the Monitoring Network section. Therefore, providing accurate and timely particulate matter measurements to the residents of Sacramento County is of the highest priority to the District. Data collected during the assessment period shows that Sacramento County meets the PM_{10} standard of 150 µg m^{-3} except for exceedances that occurred in 2018 and 2019, caused by either uncontrollable natural events or exceptional events. EPA's concurrence of these events as exceptional would exclude all exceedances days in 2018, leaving a single exceedance (on October 27, 2019) over the latest three-year period in this assessment, 2017 – 2019.

In this analysis, each site exceeded the 150 µg m^{-3} threshold if the wildfire impacted dates are included. Based on this strict threshold, each site would be ranked as high importance. However, without discounting the severe impact of these events, they are still exceptional in nature. The District has incorporated other methods for public notification during wildfire events in addition to the PM_{10} network. Therefore, it would be appropriate to assess the PM_{10} network in the absence of these events.

With the major 2018 wildfire events excluded from the analysis, it can be seen that the Sacramento-1309 T Street site measured the highest concentrations in the network, with a single exceedance of the 150 µg m^{-3} threshold in 2019 (see Table 35 and Figure 45). As sources of PM_{10} are mainly due to anthropogenic activities such as fuel combustion, road dust, and emissions from construction and farming activities, it is possible that the Sacramento-1309 T Street samples the highest concentrations due to close proximity of these sources. As described in the introduction to this document, sites were ranked based on the average concentrations used to determine the design value (DV_{ave}) for the assessment period (2015-2019). The thresholds for this analysis used the 24-hour NAAQS and are as follows:

Monitor Rank	Criteria
High	DV_{ave} > 150 µg m^{-3}
Medium	150 µg m^{-3} ≥ DV_{ave} ≥ 135 µg m^{-3}
Low	DV_{ave} < 135 µg m^{-3}

Consistent with the thresholds described in the Introduction to this document, all sites in this analysis measured average maximum concentrations over the assessment period less than 10% of the NAAQS and are therefore ranked as low importance. The results of this analysis are presented in Table 39.

Table 39 – Measured concentrations ranking.

Station Name	Measured Concentrations
North Highlands-Blackfoot	Low
Sacramento-Del Paso Manor	Low
Sacramento-1309 T Street	Low
Sacramento-Branch Center #2	Low

Deviation from NAAQS

In this analysis, the maximum 24-hour concentration was averaged over the three-year period from 2017 to 2019 to provide a more accurate representation comparison to the NAAQS (24-hour average not to be exceeded more than once per year on average over 3 years). The thresholds for this analysis, as outlined in the Introduction to this document, are as follows:

Monitor Rank	Criteria
High	|Deviation| < 15 µg m^{-3}
Medium	15 µg m^{-3} ≥ |Deviation| ≥ 30 µg m^{-3}
Low	|Deviation| > 30 µg m^{-3}

As shown in Table 40, the deviation from NAAQS analysis shows for the 24-hour standard, Sacramento-1309 T Street has the lowest value, or highest ranking based on the Network Assessment Guidance definition that “[s]ites measuring concentrations (design values) that are very close to the NAAQS exceedance threshold are ranked highest in this analysis”. All other sites are considered low importance for this analysis.

Table 40 – 2017-2019 average maximum 24-hr PM_{10} concentration and deviation from NAAQS analysis.

Station Name	2017-2019 Average Maximum 24-hr PM_{10} Concentration* ($\mu g\ m^{-3}$)	Deviation from NAAQS ($\mu g\ m^{-3}$)	Ranking
North Highlands-Blackfoot	56	94	Low
Sacramento-Del Paso Manor	51	99	Low
Sacramento-1309 T Street	157**	7	High
Sacramento-Branch Center #2	66	84	Low

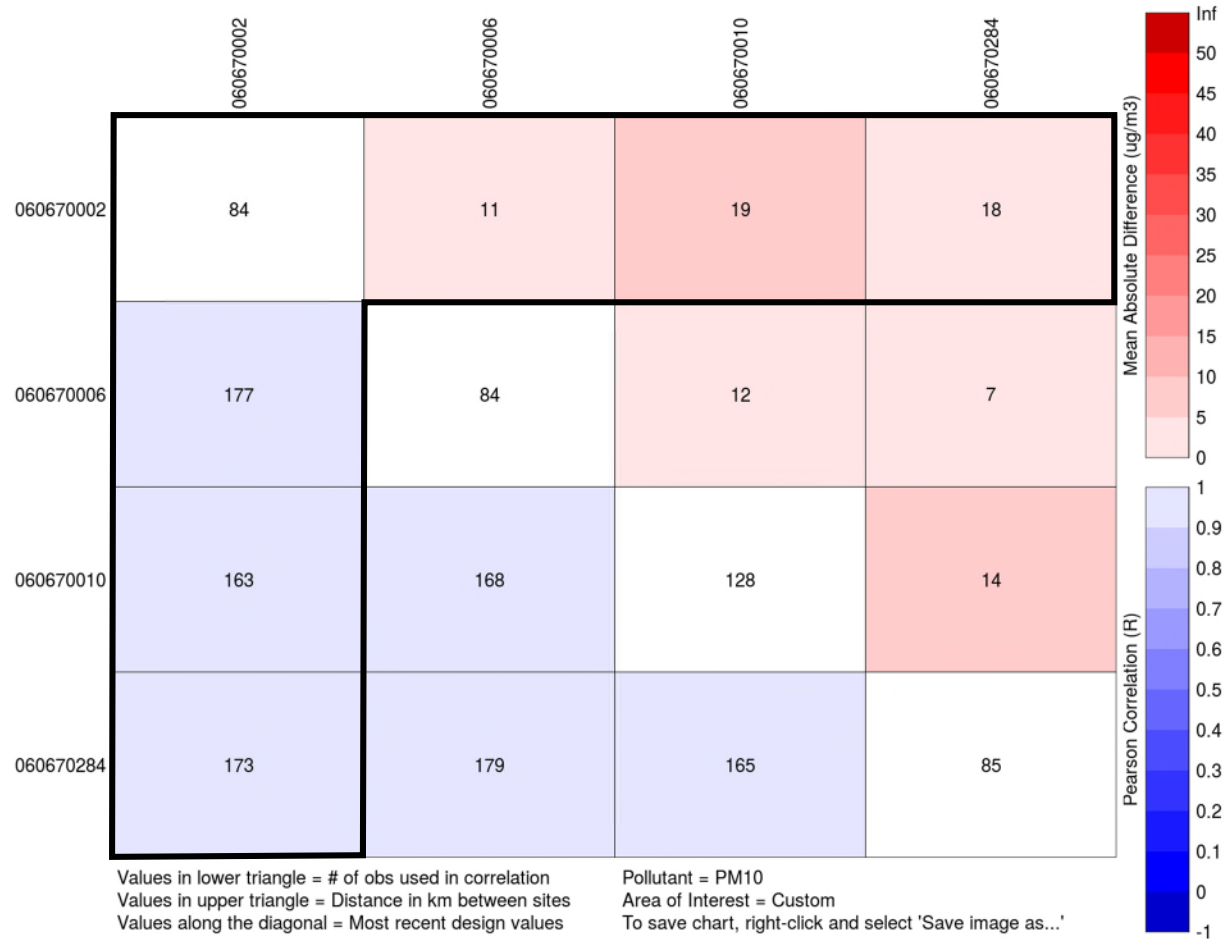
* Average concentrations are calculated with exceptional event data excluded.

** A preliminary review showed it may be caused by wildfire smoke and a high wind dust event.

PM_{10} Monitor-to-Monitor Correlation Analysis

PM_{10} concentrations were compared for redundancy using a correlation matrix analysis. Figure 46 shows a correlation matrix for all PM_{10} monitors in Sacramento County provided by the NetAssess2020 v1.1 tool. The raw values from the correlation matrix are shown in Table 41. Included in the matrix are Pearson correlations, mean absolute differences, number of observations used in the correlation, distance in kilometers between the sites, and the 2018 design values. The correlation matrix helps to determine sites within the network that can be considered redundant. Sites with high correlation, low absolute difference, and close proximities are considered redundant in this analysis.

Monitor-to-monitor correlation analysis found that based on the square of the Pearson coefficients (R^2), all four of the monitors within Sacramento County were moderately correlated ($R^2 > 0.85$) with at least one other monitor. The highest correlations were between the North Highlands-Blackfoot site and the Sacramento-1309 T Street and Sacramento-Branch Center #2 sites. The high correlation between the sites could be in part due to seasonal and regional-scale factors such as the relatively homogenous terrain throughout the county, widespread wildfire impacts, and consistent meteorological conditions (e.g. wintertime temperature inversions and wind events). These high correlations indicate that concentrations tend to fluctuate in unison at each of these sites; however, even though the PM_{10} concentrations are highly correlated, the magnitude of the measured concentrations can vary at time. Wildfire smoke can often remain elevated at 10s to 100s of feet above the surface, but when the smoke plume reaches the surface, the concentrations can easily exceed the NAAQS. Alerting the public of this rapid increase in PM_{10} concentrations is of utmost importance and the highest priority of the District. Also, during high wind events, not all monitors are necessarily impacted by blowing dust to the same magnitude. Often, the sites closer to open fields, construction sites, or other sources of loose particles can sample much higher than other sites. This highlights not only the general trends, but localized variability of PM_{10} pollution throughout the county. The last factor to include in this analysis is the proximity of the stations to each other. The Sacramento-Del Paso Manor and Sacramento-Branch Center #2 sites are the closest in proximity at 7 km, however, do not meet the criteria for the lowest rank at less than 25% of the maximum distance between any two PM_{10} monitors.



060670002 – North Highlands-Blackfoot
060670006 – Sacramento-Del Paso Manor
060670010 – Sacramento-1309 T Street
060670284 – Sacramento-Branch Center #2

Figure 46 – Correlation matrix for PM_{10} monitors serving Sacramento County (source: NetAssess2020 v1.1). The lower triangle refers to the blue shaded boxes and the upper triangle refers to the red shaded boxes. Most recent design values are for the 2018 design value year. The area within the black box indicates correlations with the North Highlands-Blackfoot monitor.

Based on thresholds outlined in the Introduction of this document, the criteria for this analysis are as follows:

Monitor Rank	Criteria
High (meets 1 or less of the criteria)	Highest pairwise $R^2 > 0.75$
Medium (meets 2 of the criteria)	Distance between sites < 5 km
Low (meets 3 of the criteria)	Mean Difference < 1.35 µg m^{-3}

Table 41 – Monitor to monitor correlation data. **Red and bold** represent conditions considered to be redundant (R^2 > 0.75, distance between sites < 25% of maximum distance between any two sites, mean difference < 25% of maximum mean difference between any two sites). All correlations with the North Highlands-Blackfoot site are italicized.

Site #1	Site #2	Distance Between Sites (km)	Number of Observations	Pearson Correlation	R^2	Mean Difference (µg m^{-3})
NH	*DPM*	*11*	*177*	*0.9875*	***0.975***	*2.1638*
NH	*TST*	*19*	*163*	*0.9355*	***0.875***	*5.4172*
NH	*BC*	*18*	*173*	*0.9665*	***0.934***	*4.2312*
DPM	TST	12	168	0.946	**0.895**	4.8929
DPM	BC	7	179	0.9587	**0.919**	4.352
TST	BC	14	165	0.9217	**0.850**	5.0242

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor
TST – Sacramento-1309 T Street
BC – Sacramento-Branch Center #2

This monitor-to-monitor correlation analysis shows that all sites meet only one of the three criteria for redundancy. Therefore, all sites are ranked as high importance due to their perceived uniqueness in this analysis. The rankings for this analysis are summarized in Table 42.

Table 42 – Monitor-to-monitor correlation ranking.

Station Name	Monitor-to-Monitor Rank
North Highlands-Blackfoot	High
Sacramento-Del Paso Manor	High
Sacramento-1309 T Street	High
Sacramento-Branch Center #2	High

Trend Analysis

Monitors that have a long historical record are valuable for tracking trends. In this analysis, sites are ranked based on the duration of the continuous measurement record as described in the Introduction to this document. The thresholds for this analysis are as follows:

Monitor Rank	Criteria
High	Trend ≥ 30 years
Medium	30 years > Trend ≥ 10 years
Low	Trend < 10 years

Table 43 shows the year that PM_{10} measurements began at each of the stations serving Sacramento County. Sacramento-Del Paso Manor has the longest historical record of the current sites in the network as it was the first PM_{10} monitor operating in Sacramento County. Based on this analysis, all sites are of high importance as they all are equal to or greater than 75% of the maximum number of years of PM_{10} historical record.

Table 43 – Date of operation for each PM_{10} station serving Sacramento County.

Station Name	Begin Year of PM_{10} Operation	Trend Rank
North Highlands-Blackfoot	1989	High
Sacramento-Del Paso Manor	1980	High
Sacramento-1309 T Street	1990	High
Sacramento-Branch Center #2	1989	High

PM_{10} Monitor Removal Bias Analysis

Each monitor was analyzed to determine the change in spatial concentrations interpolated across Sacramento County if the monitor was removed. Table 44 and Figure 47 present the results of the removal bias analysis and the maximum change in PM_{10} concentrations in Sacramento County if each PM_{10} monitor in the District's network was individually removed as calculated by the NetAssess2020 v1.1 tool.

The change in concentration at a site indicates the bias which may be observed if the individual monitor were removed. Per the Network Assessment Guidance, "[t]he greater the bias, the more important the site is for interpolation." Based on the thresholds outlined in the Introduction to this document, the thresholds for this analysis are as follows, where MRB is the mean relative bias:

Monitor Rank	Criteria	Criteria (NH Removed)
High	$\|MRB\| \geq 2.4\ \mu g\ m^{-3}$	$\|MRB\| \geq 2.3\ \mu g\ m^{-3}$
Medium	$2.4\ \mu g\ m^{-3} > \|MRB\| \geq 0.8\ \mu g\ m^{-3}$	$2.3\ \mu g\ m^{-3} > \|MRB\| \geq 0.8\ \mu g\ m^{-3}$
Low	$\|MRB\| < 0.8\ \mu g\ m^{-3}$	$\|MRB\| < 0.8\ \mu g\ m^{-3}$

Table 44 below indicates that removal of the Sacramento-Del Paso Manor, Sacramento-1309 T Street, or Sacramento-Branch Center #2 PM_{10} monitors could introduce a bias in concentration interpolation exceeding the 25% of the maximum mean removal bias threshold for medium importance. Sacramento-1309 T Street exceeds 75% of the maximum mean removal bias and is therefore ranked as high importance for this analysis.

As mentioned previously, the Sacramento nonattainment area will be able to continue to demonstrate maintenance for the 24-hour PM_{10} standard through 2033. All exceedances of the 24-hour standard of 150 $\mu g\ m^{-3}$ in the assessment period have been due to events which can be deemed exceptional, such as wildfire smoke and high winds. Therefore, in relation to the 24-hour PM_{10} NAAQS of 150 $\mu g\ m^{-3}$, these biases would have little impact on maintenance or attainment statuses. The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 44. No changes to the rankings were observed. The rankings are summarized in Table 45.

Table 44 – PM_{10} monitoring network removal bias results.

		NH Station Removed
Station Name	Mean Removal Bias ($\mu g\ m^{-3}$)	Mean Removal Bias ($\mu g\ m^{-3}$)
North Highlands-Blackfoot	0.2	N/A
Sacramento-Del Paso Manor	1.3	1.6
Sacramento-1309 T Street	-3.2	-3.1

Sacramento-Branch Center #2	-1.8	-1.8

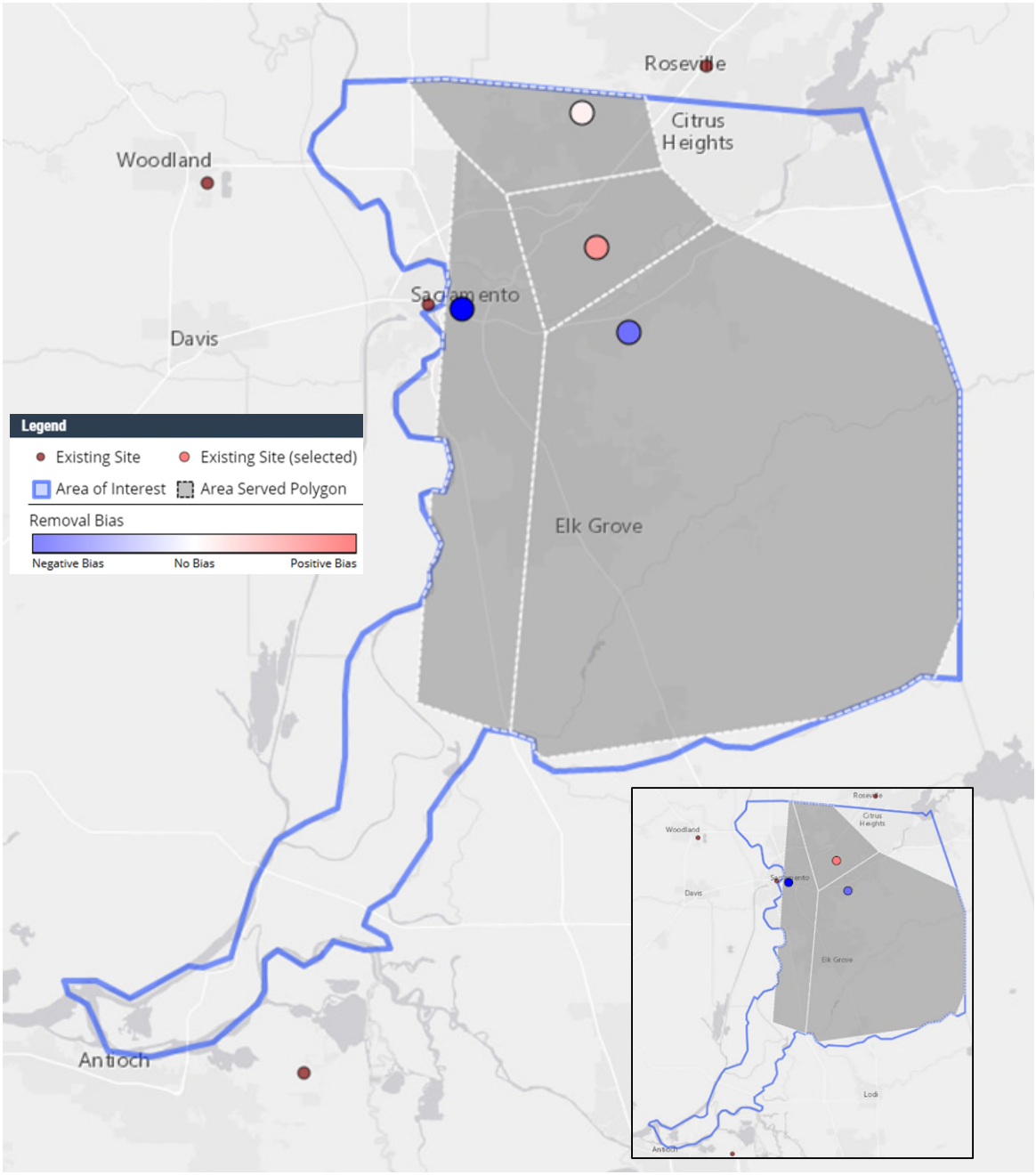


Figure 47 – PM_{10} removal bias analysis in Sacramento County. Inset shows analysis with the North Highlands-Blackfoot station removed.

Table 45 – Removal bias rank.

Station Name	Removal Bias Rank	Removal Bias Rank NH Removed from Analysis
North Highlands-Blackfoot	Low	
Sacramento-Del Paso Manor	Medium	Medium
Sacramento-1309 T Street	High	High
Sacramento-Branch Center #2	Medium	Medium

PM_{10} Minimum Number of Monitors Required

The minimum number of monitors required under Appendix D of 40 CFR Part 58 and number of sites in the Sacramento MSA are listed in Table 46. Note that there are three (3) active sites in Sacramento County as shown in Figure 43. CBSAs with a population above 1,000,000 and ambient PM_{10} concentrations less than 80 percent of the PM_{10} NAAQS must have a minimum of two active PM_{10} monitors[59]. There are currently three (3) active PM_{10} monitors located in the District's network (BC, DPM, TST).

Table 46 – Minimum monitoring requirements within Sacramento MSA.

Sites Required*	Active Sites in Sacramento MSA	Additional Sites Needed	2019 Design Value and Site ID**
2-4	7	0	Expected number of exceedances (3-yr average): (1) 4.1 days at NH and DPM (2) 0.0 days

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor

* Wildfire smoke in 2017 and 2018 impacted multiple air monitoring stations. While the District is addressing some impacts under the Exceptional Event Rule (81 FR 68216), other smoke impacts are short of the rule threshold and could not be addressed. Without any smoke impacts, historical data from 2009 through 2018 shows the maximum PM_{10} ambient concentration in Sacramento MSA is 70% of the NAAQS. Therefore, existing monitors meet the monitoring requirements in 40 CFR 58, Appendix D, as well as the needs of communities in local air districts. The District is committed to working with U.S. EPA, CARB, and other local air districts to ensure that monitoring levels continue to protect public health and safety.
** (1) as-is measurement with wildfire impact and (2) exclusion of air quality measurements with wildfire impact.

[59] Wildfire smoke in 2017 and 2018 impacted multiple air monitoring stations. While the District is addressing some impacts under the Exceptional Event Rule (81 FR 68216), other smoke impacts are short of the rule threshold and could not be addressed. Without any smoke impacts, historical data from 2009 through 2018 shows the maximum PM_{10} ambient concentration in Sacramento MSA is 70% of the NAAQS. Therefore, existing monitors meet the monitoring requirements in 40 CFR 58, Appendix D, as well as the needs of communities in local air districts. The District is committed to working with EPA, CARB, and other local air districts to ensure that monitoring levels continue to protect public health and safety.

Conclusions

Table 47 is a summary of the District's PM_{10} monitor rankings from the analyses performed in this section. An overall ranking was calculated for each site by assigning a value to each rank (1 – low, 2 – medium, 3 – high) and summing over all analyses.

Table 47 – PM_{10} monitor ranking summary. Overall score is shaded red, with highest overall score darkest.

Station Name	Population-Served	Area-Served	Measured Concentrations	Deviation from 24-hour NAAQS	Monitor-to-Monitor	Trend	Removal Bias	Overall
North Highlands-Blackfoot	Low	Low	Low	Low	High	High	Low	11
Sacramento-Del Paso Manor	Medium	Low	Low	Low	High	High	Medium	13
Sacramento-1309 T Street	High	Low	Low	Medium	High	High	High	17
Sacramento-Branch Center #2	High	High	Low	Low	High	High	Medium	16
North Highlands-Blackfoot Removed from Analysis								
Sacramento-Del Paso Manor	Medium	Low	Low	Low	High	High	Medium	13
Sacramento-1309 T Street	High	Low	Low	Medium	High	High	High	17
Sacramento-Branch Center #2	High	High	Low	Low	High	High	Medium	16

Based on Table 47, the Sacramento-1309 T Street is the highest overall ranked and therefore, most important site for PM_{10}. North Highlands-Blackfoot was originally ranked the lowest of the sites, however with the discontinuation of the station, there was no change to the other station rankings and Sacramento-Del Paso Manor became the lowest rank. As the Sacramento-Del Paso Manor site is the NCore site for Sacramento County, the station is not suitable for removal.

As mentioned in this section, the Sacramento nonattainment area will be able to continue to demonstrate maintenance for the 24-hour PM_{10} standard. Measured concentrations have been elevated more frequently as wildfires and high wind events become more common throughout much of California. Throughout the year, there are periods of elevated particulate matter which require accurate and spatial measurements for public notification throughout the county. This commitment to public notification and health is demonstrated in the District's various programs as discussed in the $PM_{2.5}$ section of this assessment. The District is also evaluating replacing the PM_{10} filter-based method to PM_{10} continuous monitoring at the Sacramento-Del Paso Manor and Sacramento-Branch Center #2 sites as continuous monitoring provides real-time air quality information to the public.

Previously in the Number of Parameters Monitored Analysis section, the Sacramento-Branch Center #2 site was shown to operate only a single parameter, PM_{10}, and is therefore considered as operating at the least possible efficiency from an operational and scientific standpoint. It was recommended to be investigated for redundancy in this section. This analysis can be found in the Redundancy Evaluation for Sacramento-Branch Center #2 Monitor section of the PM_{10} conclusions.

A recommendation from the previous 5-year Network Assessment for Sacramento County was to install a PM_{10} monitor at the Elk Grove-Bruceville station[60]. The following sections investigate this further.

Population-Served and Area-Served Analysis for Monitor at Elk Grove-Bruceville Station

In this analysis, it was shown that the area of influence for the current PM_{10} monitoring stations extend from the northernmost to the southernmost boundary of Sacramento County (Figure 44). With the removal of the North Highlands-Blackfoot monitor, the area of influence for neighboring monitors was increased northward (inset of Figure 44). However, this northward shift is minimal in magnitude to the current area of influence southward from the existing stations. The next nearest PM_{10} site to the south is located in Stockton, California, nearly 45 miles from the Sacramento-1309 T Street site (Figure 48). As seen in Figure 48, the removal of the North Highlands-Blackfoot monitor increases the area-served of the Sacramento-Branch Center #2 monitor from 56% to 76% of the total area of influence[61] and the population-served from 31% to 32%. The significant change in area with corresponding small change in population is due to area expansion in relatively sparsely populated regions of Sacramento County.

Continuing the District's commitment to public notification and health and to provide important regional background concentrations, installation of the PM_{10} monitor at the Elk Grove-Bruceville air monitoring site would increase the efficiency of and optimize the District PM_{10} network. This is a continuation of the similar recommendation from the District's 2015 Air Monitoring Network Assessment[62]. Based on estimates from the NetAssess2020 v1.1 tool, installation of the PM_{10} monitor at the Elk Grove-Bruceville station would lead to all stations representing less than 43% of the total area of influence and no more than 32% of the population (Figure 48). This effectively helps to balance the responsibility of the PM_{10} monitors in the District network as seen in Table 48. This is consistent within the core objectives of the District air monitoring network, such as to support emissions strategy development and support air pollution research. Introducing homogeneity to the spatial distribution of monitors provides valuable information for air quality modeling and research efforts such as State Implementation Plan development.

Included in this recommendation is upgrading the instrument to a continuous monitor consistent with District priorities of increasing public awareness.

[60] The District 2015 Air Monitoring Network Assessment can be found here: http://www.airquality.org/ProgramCoordination/Documents/2015%20Air%20Monitoring%20Network%20Assessment.pdf

[61] The total area of influence is calculated as the sum of all Thiessen polygons as estimated by the NetAssess2020 v1.1 tool.

[62] The District 2015 Air Monitoring Network Assessment can be found here: http://www.airquality.org/ProgramCoordination/Documents/2015%20Air%20Monitoring%20Network%20Assessment.pdf

Table 48 – Changes to the area and population served by PM_{10} monitors in Sacramento County if the North Highlands-Blackfoot monitor was discontinued entirely or installed at the Elk Grove-Bruceville station.

	Area Served			Population Served		
Site	Including NH	NH Discontinued	NH Discontinued and Installed at BRU	Including NH	NH Discontinued	NH Discontinued and Installed at BRU
NH	740			178,922		
DPM	115	212	212	202,059	316,071	316,071
TST	206	213	186	399,725	404,220	348,105
BC	1376	1376	880	345,296	345,296	255,697
BRU			779			151,749

NH – North Highlands-Blackfoot TST – Sacramento-1309 T Street BRU – Elk Grove-Bruceville
DPM – Sacramento-Del Paso Manor BC – Sacramento-Branch Center #2

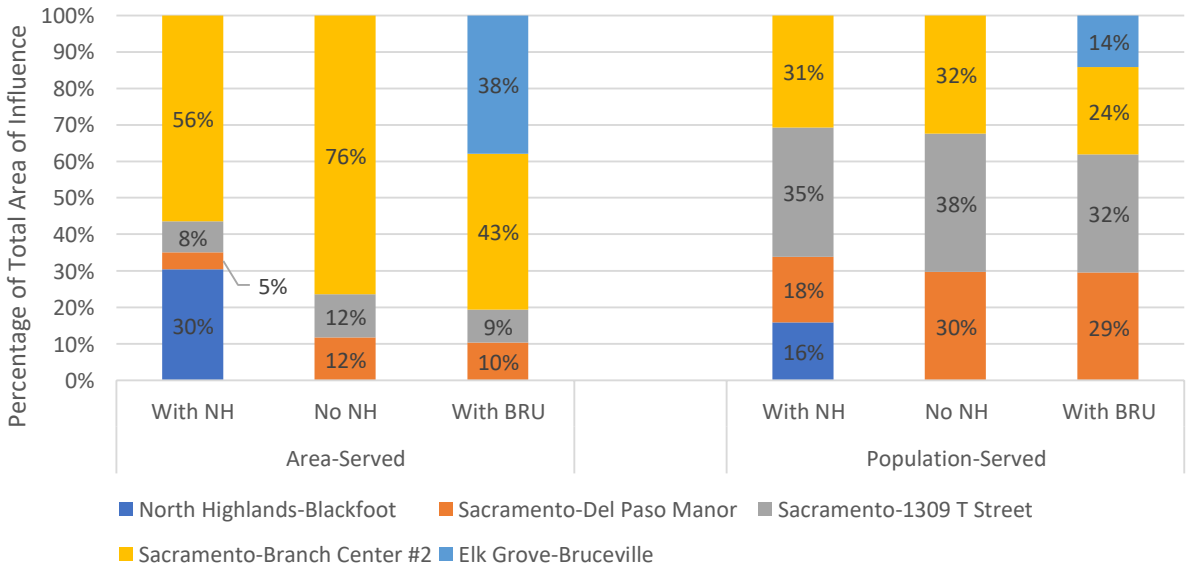


Figure 48 – Percentage of the total area of influence for area- and population-served as estimated by the NetAssess2020 v1.1 tool for three PM_{10} station scenarios: (1) With NH – including the North Highlands-Blackfoot station, (2) No NH – removing the North Highlands-Blackfoot station from the analysis, and (3) With BRU – removing the North Highlands-Blackfoot station from the analysis and adding a monitor at the Elk Grove-Bruceville station.

Additional Justification for Monitor at Elk Grove-Bruceville Station

The analyses included throughout this document provide a detailed and valuable assessment of the entire District air monitoring network. However, as the North Highlands-Blackfoot station was quickly discontinued due to reasons external to the District, some of the analyses useful in determining redundancy and station removal such as Measured Concentration, Monitor-to-Monitor Correlation, and Trends are not applicable in this situation. Therefore, additional analyses and justification are necessary

to adequately provide suitable, efficient, and scientific recommendations for this assessment. The following are additional specific reasons why the installation of the PM_{10} monitor at the Elk Grove-Bruceville Station would provide increased value to the District network.

The southernmost portion of the county includes many agricultural operations and is often downwind of some of California's most agriculturally productive land in the San Joaquin Valley. These operations can be prone to exceptional natural events such as high wind and blowing dust exacerbated by climate change enhanced drought conditions. Installation of the monitor at the Elk Grove-Bruceville location would provide valuable monitoring data for the county during these events, especially collocated with the non-FEM continuous $PM_{2.5}$ monitor currently in operation at the site.

A significant advantage to a monitor at Elk Grove-Bruceville would be that the southernmost portion of the county, which is increasingly populated as Sacramento expands[63] and represents a large portion of the environmental justice communities in Sacramento County[64] (Figure 49), will have more localized and accurate PM_{10} concentration measurements. This is consistent with the District's commitment to more effectively reduce exposure to air pollution and preserve public health, especially in the communities most disproportionally impacted by air pollution.

[63] Sacramento Area Council of Governments; https://www.sacog.org/growth-projections-2036.

[64] In this analysis, the particulate matter ($PM_{2.5}$) EJ Index was used as an estimation for PM_{10}. The EJ index is a combination of environmental and demographic information. More information is available at https://www.epa.gov/ejscreen.

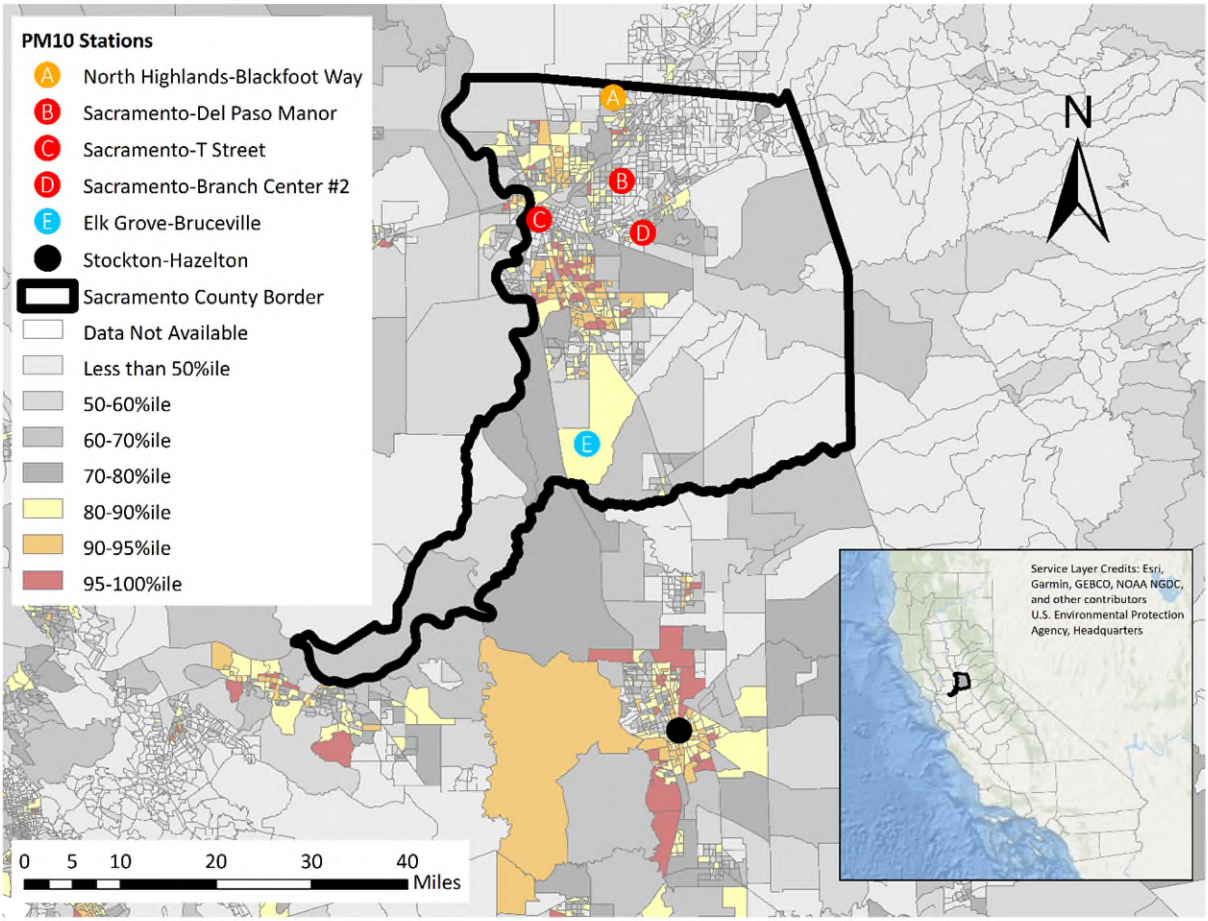


Figure 49 – District PM_{10} monitor network stations (red dots), discontinued North Highlands-Blackfoot station (orange dot), potential Elk Grove-Bruceville station (blue dot), and Stockton-Hazelton air monitoring station (black dot). Shading represents the $PM_{2.5}$ EPA EJScreen EJ Index (source: EPA[65]).

Currently PM_{10} design values fall well below the NAAQS, however in the case of unusual or naturally occurring events that can affect air quality but are not reasonably controllable (e.g. wildfire or high wind events), concentrations could be elevated to near the NAAQS in Sacramento County. In these instances, data would be excluded from regulatory decisions via the Exceptional Event Rule (81 FR 68216). The installation of a PM_{10} monitor at the Elk Grove-Bruceville monitor within the MSA would help to bridge the gap between the San Joaquin Valley air monitoring stations and the Sacramento MSA urban core (Figure 50).

[65] EPA EJScreen; https://www.epa.gov/ejscreen

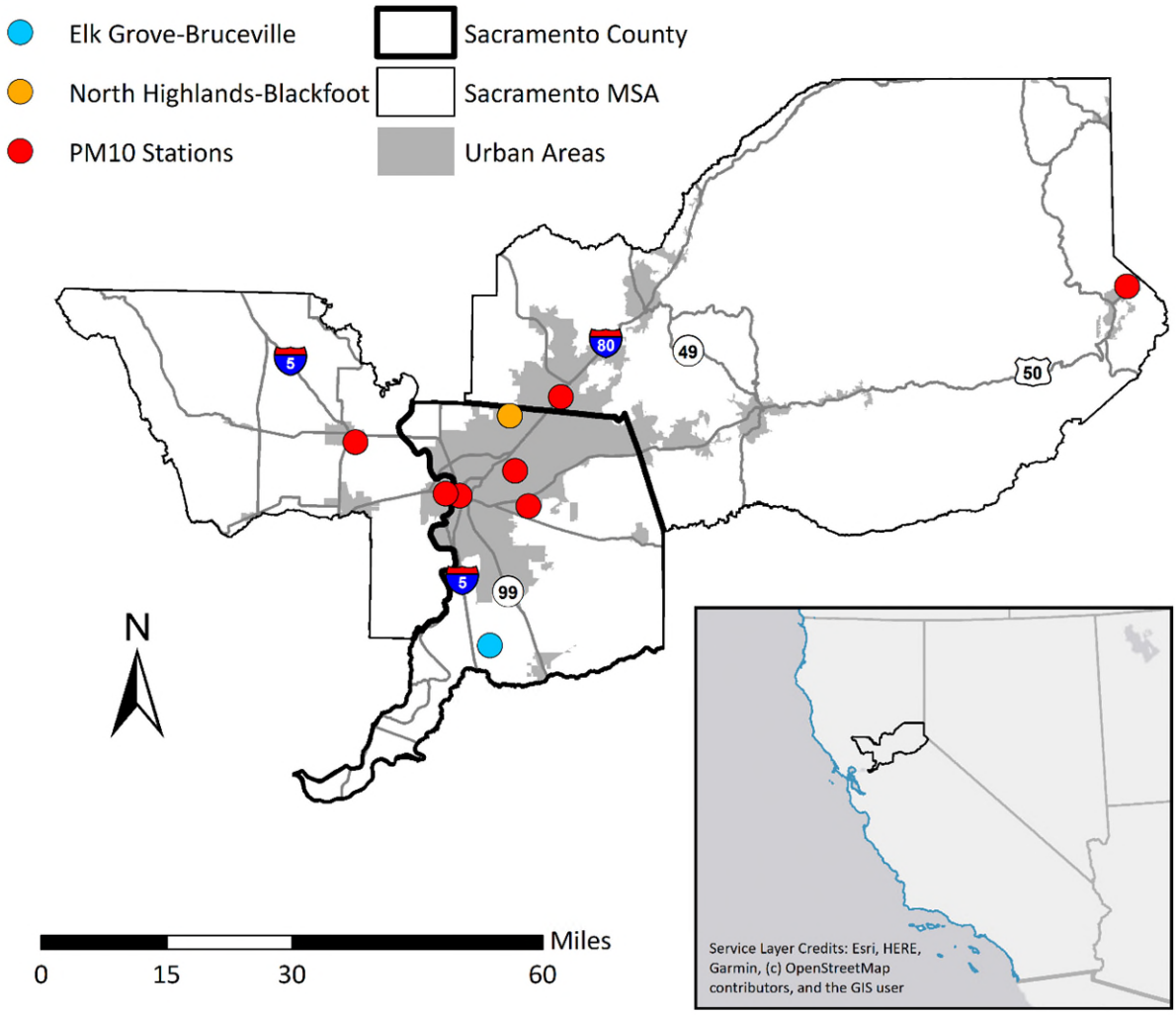


Figure 50 – PM_{10} stations within Sacramento County and the Sacramento-Roseville-Arden Arcade MSA (Sacramento MSA). The orange dot indicates the North Highlands-Blackfoot station, the blue dot indicates the Elk Grove-Bruceville station, and red dots indicate all other PM_{10} stations within the Sacramento MSA.

In the case of an exceptional event as described above, public notification of PM_{10} concentrations is paramount to alerting residents of unhealthy conditions. With the installation of the PM_{10} monitor at the Elk Grove-Bruceville location, the southernmost portion of Sacramento County would have near real-time concentrations to alert the public of elevated PM_{10} entering the county from the south. As for the northernmost portion of the county, a replacement station is recommended for the discontinued North Highlands-Blackfoot station. The process of installing a new station is generally lengthy and an operational PM_{10} monitor cannot be expected in the short term. However, the Roseville-N.Sunrise/Douglas station (AQS code: 060610006) is located only 10.8 km to the northeast and within the urban core of the Sacramento MSA. This station can be considered an urban scale monitor per 40 CFR 58 Appendix D. Per Table D-1 of Appendix D to Part 58, the station is appropriate for general/background and regional transport, and population exposure. Therefore, until the final installation of a replacement station in the northernmost portion of Sacramento County is complete, the

Roseville-N.Sunrise/Douglas station provides adequate monitoring in the case of an event causing anomalous PM_{10} concentrations.

Redundancy Evaluation for Sacramento-Branch Center #2 Monitor

Previously in the Number of Parameters Monitored Analysis section, the Sacramento-Branch Center #2 site was shown to operate only a single parameter, PM_{10}, and is therefore considered as operating at the least possible efficiency from an operational and scientific standpoint. It was recommended to be investigated for redundancy in this section. As can be seen in Table 47, the monitor is the second highest ranked of the four monitors in Sacramento County. Therefore, for the monitor to be considered redundant, or suitable for removal or relocation, each of the high rankings must be justified that if the monitor was removed or relocated it would not result in negatively impacting the network. In fact, the removal or relocation of the monitor should be shown to increase the operational and scientific value of the network. As mentioned previously, it is a recommendation of this assessment that a replacement station be installed for the discontinued North Highlands-Blackfoot to monitor for PM_{10} at a future site near the location of the removed station. Therefore, each of the high-ranking analyses for the Sacramento-Branch Center #2 site will be investigated below as if the North Highlands-Blackfoot site remained to act as a surrogate for a station within that community.

Population-Served and Area-Served Analysis

As was shown in previous sections of this conclusion, it is recommended that a PM_{10} monitor be installed at the Elk Grove-Bruceville air monitoring site. This is a continuation of the similar recommendation from the District's 2015 Air Monitoring Network Assessment[66]. Therefore, the Sacramento-Branch Center #2 monitor will be evaluated as if this recommendation is concurred. A map of all PM_{10} stations in this analysis are shown in Figure 51.

Based on estimates from the NetAssess2020 v1.1 tool, removal of the PM_{10} monitor from Sacramento-Branch Center #2 and establishing a monitor at the Elk Grove-Bruceville station would reduce the maximum area served by any PM_{10} monitor in the network from 1,376 to 1,043 km^2, a 24% reduction in area (Table 48). This reduction is balanced by an increase in area for the Sacramento-Del Paso Manor monitor from 115 km^2 to 709 km^2 and a minor reduction of area for the Sacramento-T Street monitor.

This change in monitor locations would effectively change the population served from 345,296 at the Sacramento-Branch Center #2 monitor to 194,171 persons at the Elk Grove-Bruceville monitor with an increase in population served at Sacramento-Del Paso Manor to compensate (Table 48). The Sacramento-T Street monitor remains the highest population served, increasing by a minimal 0.4%. This effectively helps to balance the responsibility of the PM_{10} monitors in the District network. This is consistent within the core objectives of the District air monitoring network, such as to support emissions strategy development and support air pollution research. Introducing homogeneity to the spatial distribution of monitors provides valuable information for air quality modeling and research efforts such as State Implementation Plan development.

[66] The District 2015 Air Monitoring Network Assessment can be found here: http://www.airquality.org/ProgramCoordination/Documents/2015%20Air%20Monitoring%20Network%20Assessment.pdf

Table 49 – Changes to the area and population served by PM_{10} monitors in Sacramento County if the Sacramento-Branch Center #2 monitor was discontinued and if the monitor was relocated to Elk Grove-Bruceville.

	Area Served		Population Served	
Site	Current	BC Removed and BRU Established	Current	BC Removed and BRU Established
NH*	118	118	151,035	151,035
DPM	115	709	202,059	357,483
TST	206	201	399,725	401,461
BC	1,376		345,296	
BRU		1,043		194,171

NH – North Highlands-Blackfoot TST – Sacramento-1309 T Street BRU – Elk Grove-Bruceville
DPM – Sacramento-Del Paso Manor BC – Sacramento-Branch Center #2

* The exact location of the removed North Highlands-Blackfoot station is used as a surrogate for a replacement station within the community.

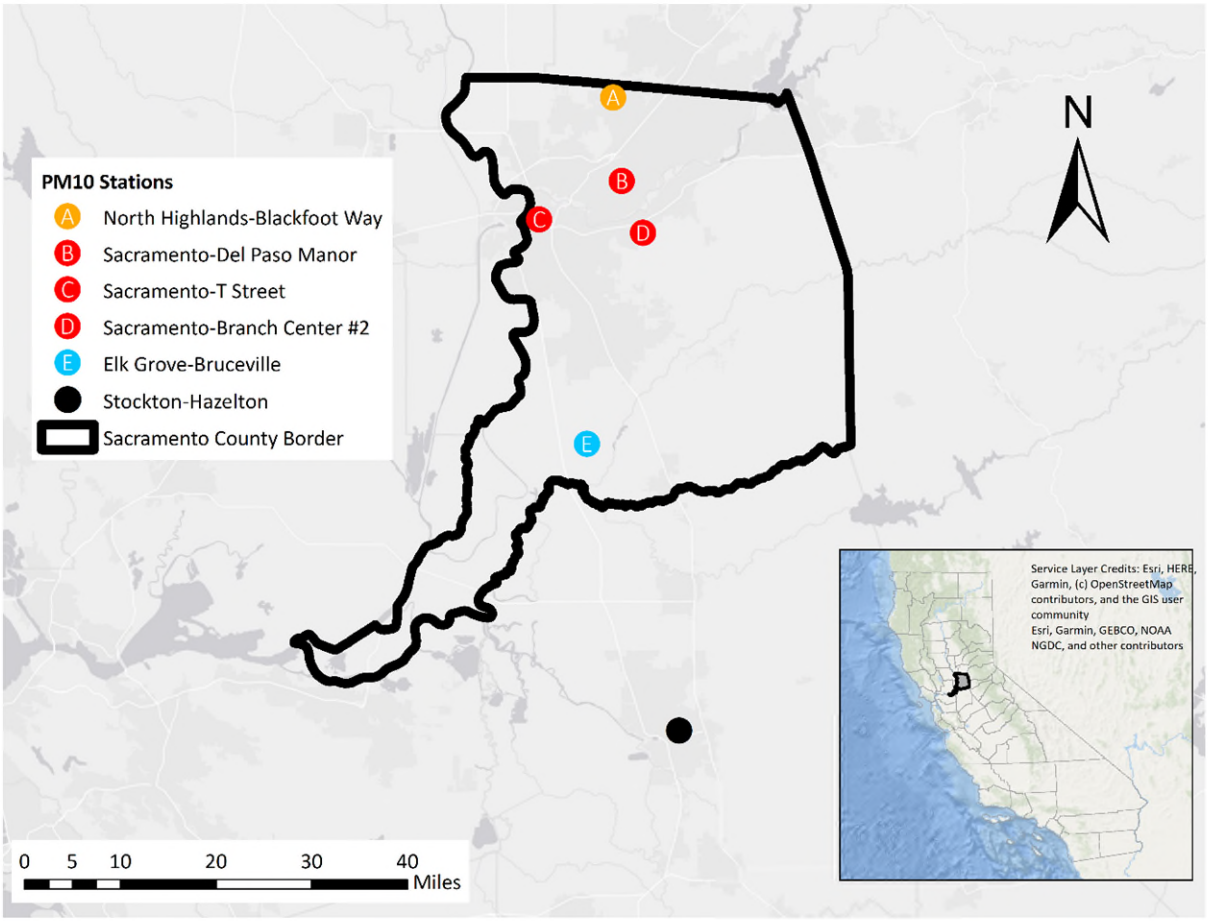


Figure 51 – District PM10 monitor network active sites (red dots), recommended Elk Grove-Bruceville site (blue dot), location of removed North Highlands-Blackfoot station (orange dot), and the Stockton-Hazelton air monitoring station (black dot).

Trend Analysis

As seen in Table 43, the Sacramento-Branch Center #2 monitor has a long historical trend (operation began in 1989) and ranks high for the PM_{10} trend analysis. However, the Sacramento-Del Paso Manor monitor has an even longer history (operation began in 1980), and as seen in Table 41, is highly correlated with the Sacramento-Branch Center #2 PM_{10} monitor ($R^2 > 0.9$). Therefore, if the Sacramento-Branch Center #2 monitor is considered redundant with the Sacramento-Del Paso Manor monitor based on the monitor-to-monitor correlation analysis, then the long historical trend is acceptable to terminate as the Sacramento-Del Paso Manor monitor has been proven to provide highly correlated data for a longer historical period.

Monitor-to-Monitor Correlation Analysis

In the monitor-to-monitor correlation analysis, three criteria were used to determine whether sites were deemed as redundant: (1) the square of the Pearson coefficient (R^2), (2) the distance between the stations, and (3) the mean difference in absolute units between sites. The usefulness of these three criteria is that the analysis investigates different aspects of uniqueness of the sites. However, in the case

of the PM_{10} monitor-to-monitor correlation analysis, the ranking can be investigated in further detail. First, the Network Assessment Guidance clearly specifies that "[m]onitors with concentrations that correlate well (e.g., $R^2 > 0.75$) with concentrations at another monitor may be redundant." The Sacramento-Branch Center #2 sites thoroughly exceeds this threshold as shown in Table 41, and therefore based on the guidance alone can be considered redundant. When investigating the distance between sites, sites are in general more highly correlated the closer they are to each other. This is true in this case as well, as the Sacramento-Branch Center #2 and the Sacramento-Del Paso Manor sites are only 7 km apart, the shortest distance between any two PM_{10} monitors in the network. As for the mean difference between sites, even though none of the monitor pairs met the criteria for low ranking, or possible redundancy (mean difference < 25% of the maximum mean difference between any two sites), the maximum mean difference between any site was only a fraction of the 150 µg m^{-3} 24-hour PM_{10} NAAQS at 5.4 µg m^{-3}. As described previously, the PM_{10} monitors in the Sacramento nonattainment area will be able to continue to demonstrate maintenance for the 24-hour PM_{10} standard through 2033, and all exceedances of the standard throughout the assessment period have been due to events, which can be deemed exceptional, such as wildfire smoke and high winds. In relation to the 24-hour PM_{10} NAAQS of 150 µg m^{-3}, these biases would have little impact on maintenance or attainment statuses. Therefore, based on further investigation of the monitor-to-monitor correlation analysis, the Sacramento-Branch Center #2 monitor can be considered redundant with the Sacramento-Del Paso Manor monitor and is suitable for discontinuation.

Additional Justification for Monitor and Station Discontinuation

The analyses included throughout this document provide a detailed and valuable assessment of the entire District air monitoring network. However, there is a major additional reason why the discontinuation of the Sacramento-Branch Center #2 PM_{10} monitor and associated station would provide increased value to the District network. As shown in the Number of Parameters Monitored analysis, PM_{10} is the only pollutant currently sampled at the Sacramento-Branch Center #2 site. Therefore, discontinuation of the Sacramento-Branch Center #2 PM_{10} monitor and discontinuation of the Sacramento-Branch Center#2 air monitoring station would release valuable resources to the rest of the District network.

Overall Conclusions and Recommendations

The current and proposed network adequately meets all EPA monitoring requirements and covers various particulate matter monitoring purposes consistent with District monitoring goals and objectives. The following changes are recommended to improve the efficiency and efficacy of the network:

- Install a continuous PM_{10} monitor at the Elk Grove-Bruceville air monitoring station.
- Install a replacement air monitoring station and PM_{10} monitor near the discontinued North Highlands-Blackfoot location.
- Discontinue the Sacramento-Branch Center #2 PM_{10} monitor and Sacramento-Branch Center #2 air monitoring station when a replacement air monitoring station for the North Highland-Blackfoot location is installed.

Nitrogen Dioxide (NO_2) Network Analysis

Monitoring Objectives

Nitrogen dioxide (NO_2) is a component of highly reactive oxides of nitrogen and is emitted into the atmosphere largely through burning of fuel. NO_2 forms primarily from emissions from cars, trucks and buses, power plants, and off-road equipment[67].

Sacramento County has a total of five (5) active SLAMS NO_2 monitoring stations as shown in Figure 52. The North Highlands-Blackfoot station as discussed in the Recent Notable Modifications to the Network section was discontinued after the assessment period. Based on the characteristics of the sites, including the population served and the area served, each site can be designated as background, population oriented, source oriented, or high concentration monitoring locations as depicted in Table 50.

[67] https://www.epa.gov/no2-pollution/basic-information-about-no2#What%20is%20NO2

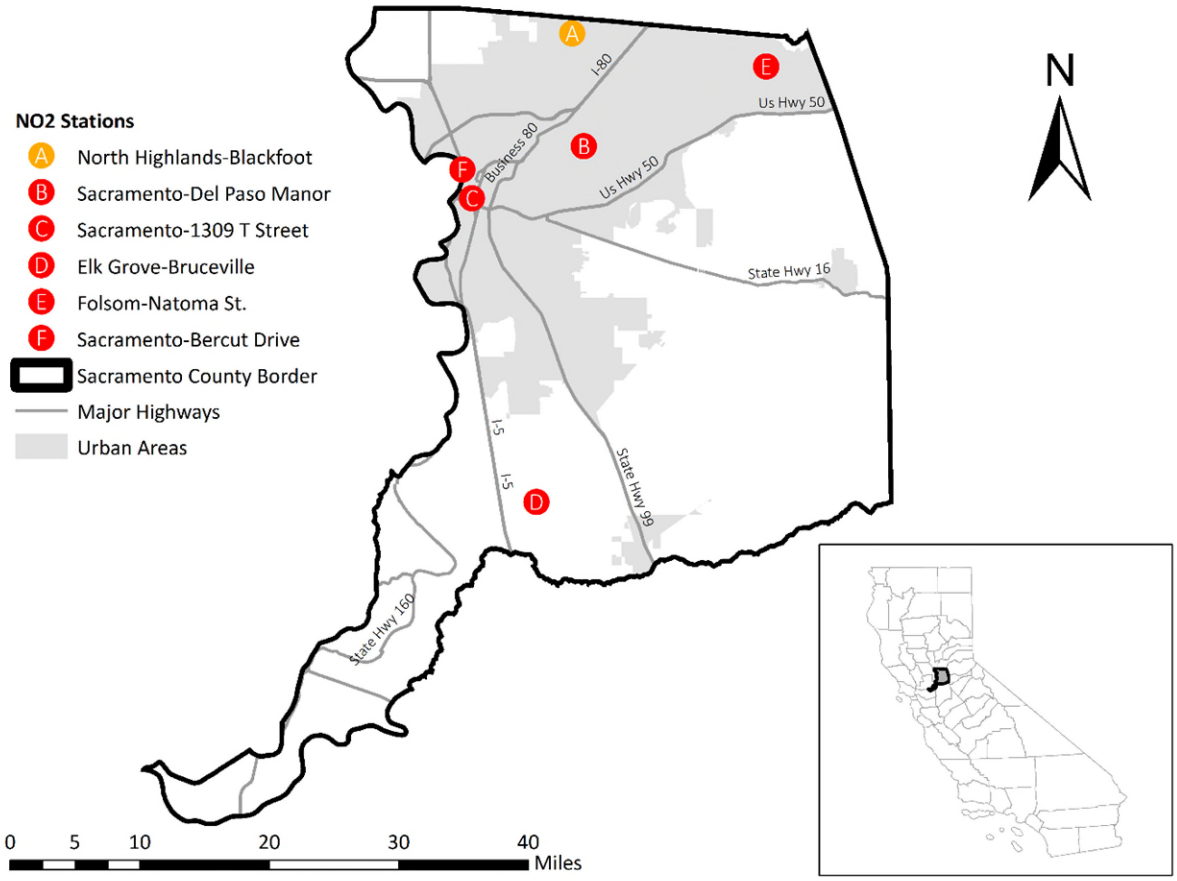


Figure 52 – NO_2 Network in Sacramento County. Red markers indicate active monitors. Orange marker indicates an active monitor during the assessment period but is no longer active.

Table 50 – Monitoring type for NO_2 monitors serving Sacramento County.

Site	EPA Network Affiliation*	Monitoring Type**
North Highlands-Blackfoot	SPM	Population Oriented
Sacramento-Del Paso Manor	NCORE/PAMS	Population Oriented
Sacramento-1309 T Street		Population Oriented
Elk Grove-Bruceville	PAMS	Background
Folsom-Natoma St.	PAMS	High Concentration
Sacramento-Bercut Drive	Near Road	Source Oriented

Note: All monitors are SLAMS (State and Local Air Monitoring Stations) monitor type unless otherwise noted.
* NCORE (National Core Multi-pollutant Monitoring Stations), SPM (Special Purpose Monitor not part of SLAMS), PAMS (Photochemical Assessment Monitoring Station).
** These objectives are consistent with EPA monitoring types as listed in 40 CFR Part 58, Appendix D.

In 2010, EPA revised the NO_2 annual NAAQS by establishing a 1-hour standard at the level of 100 ppb. The design value is the annual 98th percentile of the daily maximum 1-hour concentration values, averaged over three consecutive years. In 2010, EPA also retained the existing annual NO_2 NAAQS at the level of 53 ppb. As of publication, EPA has designated all areas of the United States as unclassifiable/attainment.

Sacramento County has one site, Sacramento-Bercut Drive, that began operation in October 2015, and operates as part of the EPA Near Road monitoring network. The Near Road monitoring network was initiated as part of the EPA 2010 NO_2 NAAQS review. The Sacramento-Bercut Drive station satisfies part of the near-road monitoring requirement[68]. Sacramento-Del Paso Manor satisfies the PAMS and area-wide monitoring requirements.

NO_2 Network Area- and Population-Served Analyses

Spatial analysis techniques were evaluated to determine whether the current NO_2 stations meet the objectives of the monitoring network. Thiessen polygons, as described previously, were generated by the NetAssess2020 v1.1 tool to determine the spatial representation of each of the six (6) NO_2 monitoring stations located in Sacramento County. The following sections present the findings for area- and population-served analyses for the NO_2 network. Note that as seen in Table 50, some of the NO_2 stations are affiliated with EPA networks and are, therefore, required regardless of these analyses.

The population within Sacramento County represented by each monitoring site was counted within the Thiessen polygons by NetAssess2020 v1.1 using 2010 US Census data. Area- and population-served analyses are presented in Table 51. Figure 53 presents a map showing the location and area of influence for each NO_2 monitor.

Following the methods outlined in the EPA network assessment guidance, the Elk Grove-Bruceville and Folsom-Natoma St. monitors were found to be the most important NO_2 monitors based solely on area of influence at over 500 km^2. The Sacramento-Del Paso Manor monitor ranked as medium importance by exceeding the 250 km^2 threshold. All other sites serve areas less than the 250 km^2 threshold and are therefore ranked as low importance. Sacramento-1309 T Street and Sacramento-Del Paso Manor serve the most populous portions of Sacramento County at exceeding the 317,000 persons threshold and are therefore both ranked as high importance in this analysis. The Elk Grove-Bruceville monitor exceeds the 159,000 persons threshold and is ranked as medium importance. All other sites are ranked as low importance for the population-served analysis. The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 51. No changes to the rankings were observed. Site rankings are summarized in Table 51.

[68] Sacramento MSA has surpassed the 250,000 vehicles threshold for a second near-road monitoring site per 40 CFR Part 58 Appendix D, 4.3.2(a) using 2019 traffic volumes from the California Department of Transportation. From the most recent 2020 traffic volumes, Sacramento MSA falls below this threshold with a maximum vehicle AADT of 249,000 on State Route 50 near Junction Route 160 between 15th and 16th Street. The District is working with EPA and CARB to determine the appropriate timing, location, and funding for a second near-road monitoring site if necessary.

Table 51 – Area and population served by NO_2 monitors serving Sacramento County. Darker red indicates the highest values and therefore the most importance.

Station Name	Population Estimate (persons)	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
North Highlands-Blackfoot	151,035	118	Low	Low
Sacramento-Del Paso Manor	336,905	306	High	Medium
Sacramento-1309 T Street	367,698	171	High	Low
Elk Grove-Bruceville	194,171	1043	Medium	High
Folsom-Natoma St.**	131,223	517	Low	High
Sacramento-Bercut Drive	139,545	178	Low	Low

North Highlands-Blackfoot Removed from Analysis

Station Name	Population Estimate (persons)	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
Sacramento-Del Paso Manor	445,952	394	High	Medium
Sacramento-1309 T Street	367,698	171	High	Low
Elk Grove-Bruceville	194,171	1,043	Medium	High
Folsom-Natoma St.**	131,223	517	Low	High
Sacramento-Bercut Drive	149,005	193	Low	Low

* Population and area estimates based on monitor's area of influence and an approximate boundary of Sacramento County as extracted from the NetAssess2020 v1.1 tool. Population estimated with some overlapping census tracts.
** Folsom-Natoma St. site was offline due to construction in late July 2019.

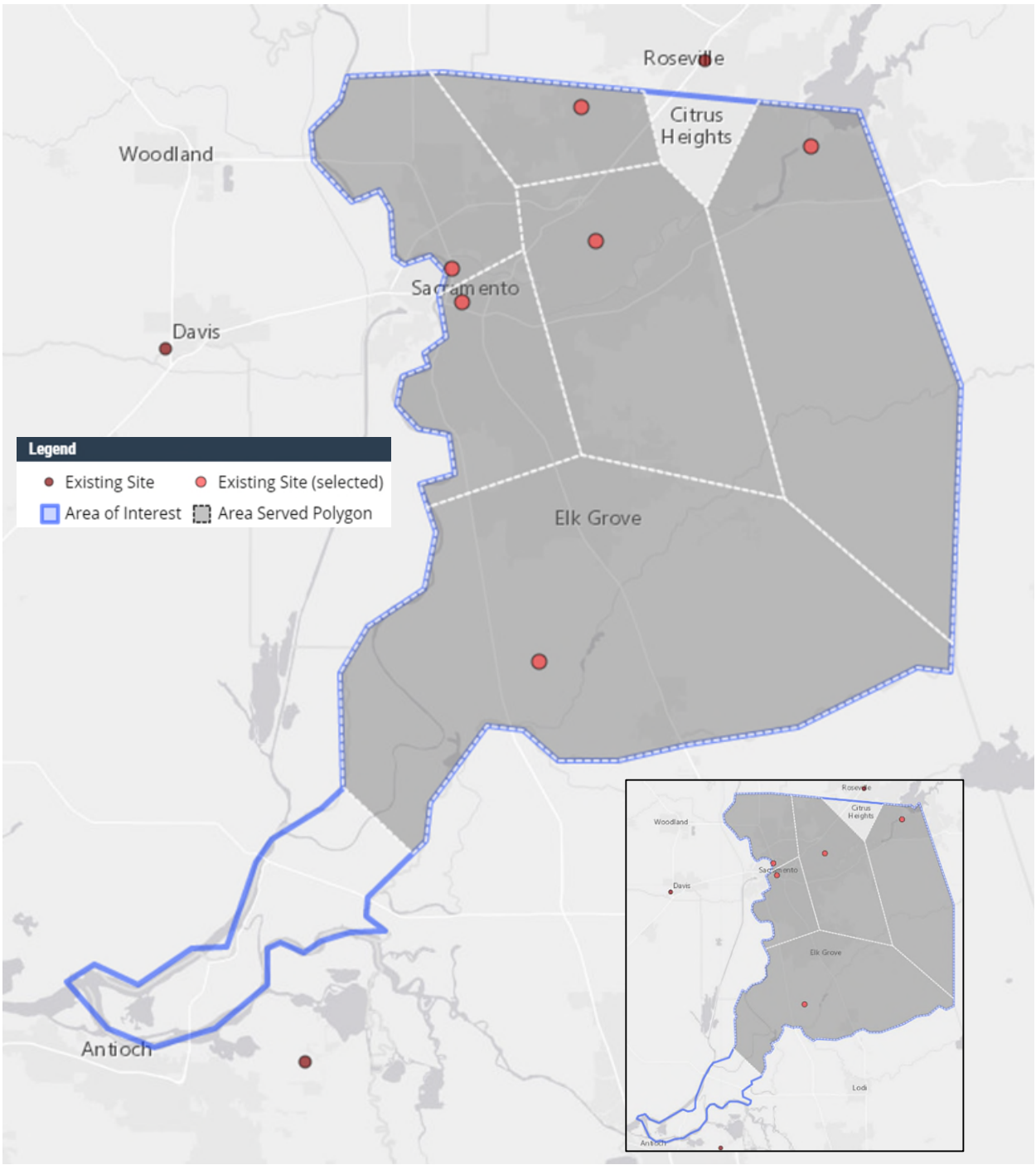


Figure 53 – NO_2 Network Area-Served analysis. Inset shows analysis with the North Highlands-Blackfoot station removed.

NO_2 Data Analyses

The NO_2 data analysis conducted was used to determine the importance of a site based on the following methods:

- measured concentrations and exceedance probability,
- deviation from NAAQS,
- monitor-to-monitor correlation,
- trend impact, and
- removal bias.

Measured Concentration and Exceedance Probability

Monitors within the District's ambient air monitoring network shown to have high levels of NO_2, design values close to the standard, and with long historical record were considered to be of high value for characterizing pollution in an area. Table 52 presents 1-hour and annual NO_2 design value concentrations for 2010 through 2019 (2010-2014 data included for historical context). The exceedance probability was not calculated in the NetAssess2020 v1.1 tool and is therefore not included in this analysis.

Table 52 – Concentration analysis for NO_2 monitors serving Sacramento County (source: EPA AQS).

Station Name	Valid Three-Year Calculated 1-hr NO_2 Design Value (ppb)*									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NH		44	44	43	44	43				
DPM	43	41	40				39	37	33	33
TST	54	51	51	51	53	51	48	47	51	54
BRU	33	32	32	33	32	29	25	22	23	23
FOL***	29	28	26				22	20	20	
BER**										
Station Name	**Valid Annual NO_2 Design Value (ppb)***									
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
NH	9	9	9	10	9	8	6			
DPM	8	9	9	8	6	7	6	6	6	6
TST	12	13	12	13	11	11	10	10	9	9
BRU	6	6	5	6	5	5	3	3	4	3
FOL***	4	5	4		4	3	3	2	3	
BER**							13		12	12

NH – North Highlands-Blackfoot TST – Sacramento-1309 T Street FOL – Folsom-Natoma St.
DPM – Sacramento-Del Paso Manor BRU – Elk Grove-Bruceville BER – Sacramento-Bercut Drive
* Unless otherwise noted, invalid design values are the result of sampler malfunctions and unmet annual completeness requirements per 40 CFR Part 58 Appendix D (source: station logs and data certification letters).
** Sacramento-Bercut Drive came online October 2015.
*** Folsom-Natoma St. site was offline due to site construction in late July 2019.

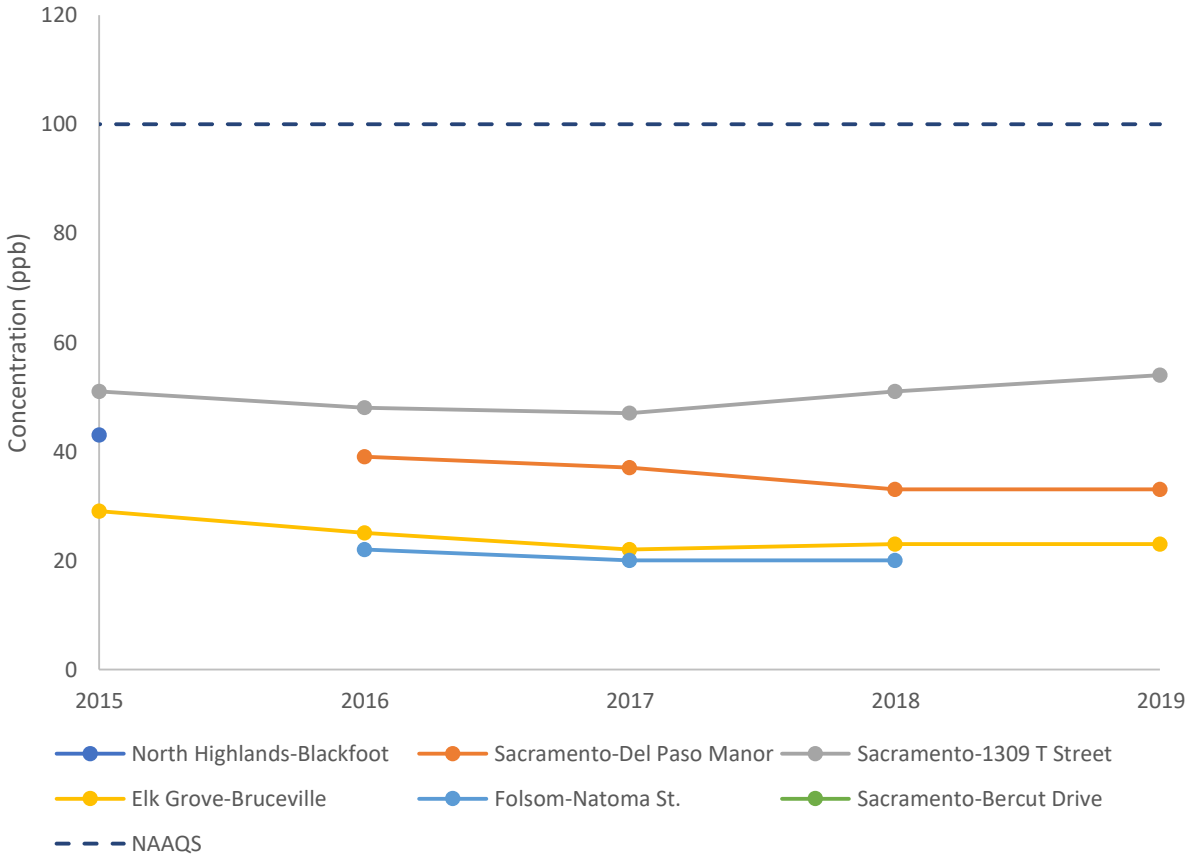


Figure 54 – 1-hr NO_2 concentration trend (Source: EPA AQS).

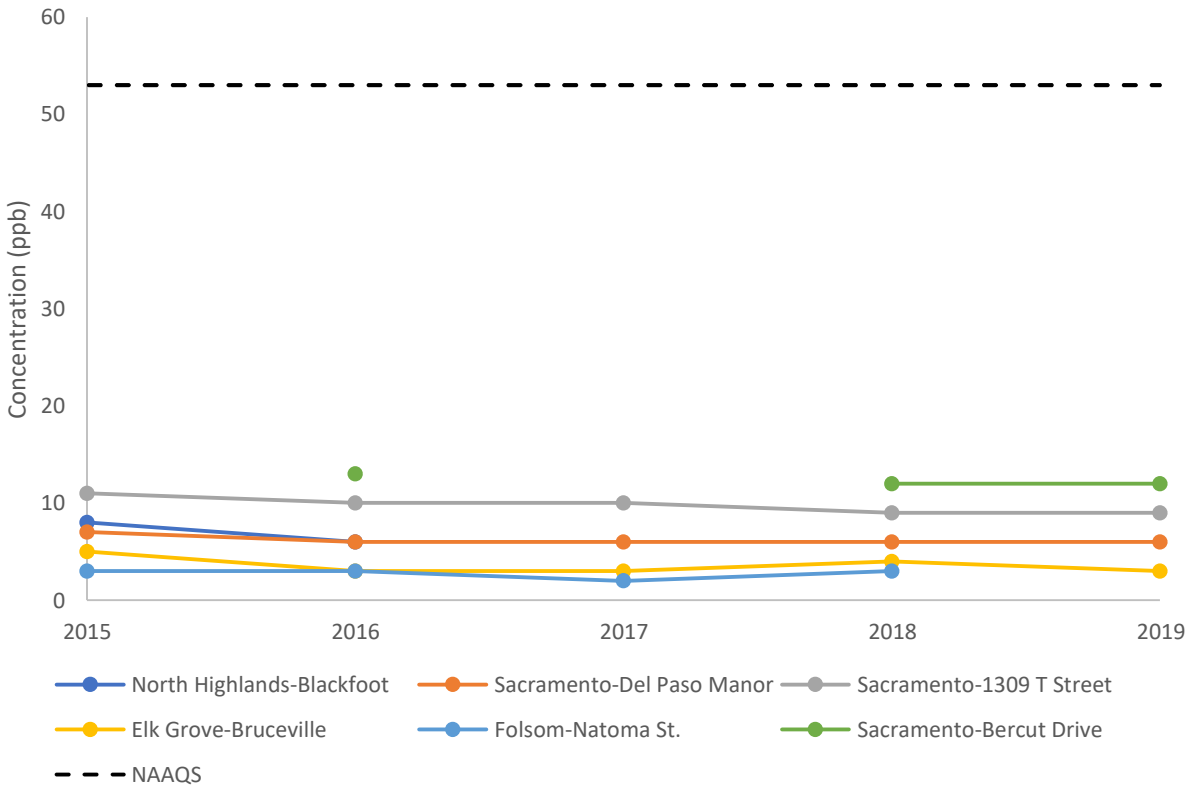


Figure 55 – Annual NO_2 concentration trend (Source: EPA AQS).

Figure 54 and Figure 55 present the 2015 through 2019 valid design values for NO_2 monitors serving Sacramento County. As described in the Network Assessment Guidance, "[m]onitors that measure high concentrations or design values are ranked higher than monitors that measure low concentrations." Per the introduction to this document, sites were ranked based on the average concentrations used to determine the design value (DV_{ave}) for the assessment period (2015-2019). The thresholds for this analysis used the 24-hour NAAQS and are as follows:

Monitor Rank	Criteria
High	$DV_{ave} > 100$ ppb
Medium	100 ppb $\geq DV_{ave} \geq 90$ ppb
Low	$DV_{ave} < 90$ ppb

Based on the data shown in Figure 54 and Figure 55, all of the sites collected data much lower than the standards, including the near-road Sacramento-Bercut Drive monitor, during the assessment period. Based on the thresholds for ranking of monitors as described in detail in the Introduction to this document, no site meets the threshold for high or medium rank. Therefore, in this analysis, all sites are ranked as low importance (see Table 53).

Table 53 – Measured concentrations ranking.

Station Name	Measured Concentrations
North Highlands-Blackfoot	Low
Sacramento-Del Paso Manor	Low
Sacramento-1309 T Street	Low
Elk Grove-Bruceville	Low
Folsom-Natoma St.	Low
Sacramento-Bercut Drive	Low

Deviation from NAAQS

The thresholds for this analysis, as outlined in the Introduction to this document, use the 1-hour and annual NAAQS and are as follows:

Monitor Rank	Criteria (1-hour)	Criteria (annual)
High	|Deviation| < 10 ppb	|Deviation| < 5.3 ppb
Medium	10 ppb ≥ |Deviation| ≥ 20 ppb	5.3 ppb ≥ |Deviation| ≥ 10.6 ppb
Low	|Deviation| > 20 ppb	|Deviation| > 10.6 ppb

As shown in Table 54, the deviation from NAAQS analysis shows for both the 1-hr and the annual NAAQS, all sites having values exceeding 20% of the NAAQS (20 ppb and 10 ppb respectively). This corresponds to the lowest ranking based on the Network Assessment Guidance that "[s]ites measuring concentrations (design values) that are very close to the NAAQS exceedance threshold are ranked highest in this analysis." Following the thresholds described in the Introduction to this document, all monitors with valid design values are ranked as low importance for this analysis. As design values for both averaging times are much lower than the NAAQS and to avoid low bias being applied to monitors without valid design values, for the NO_2 analysis only, the two standards were combined to provide a single low ranking for sites with valid design values.

Table 54 – 2019 1-hr and annual NO_2 design value and deviation from NAAQS analysis.

Station Name	2019 1-hr NO_2 Design Value (ppb)	Deviation from 1-hr NAAQS (ppb)	2019 Annual NO_2 Design Value (ppb)	Deviation from Annual NAAQS (ppb)	Ranking
North Highlands-Blackfoot					
Sacramento-Del Paso Manor	33	67	6	47	Low
Sacramento-1309 T Street	54	46	9	44	Low
Elk Grove-Bruceville	23	77	3	50	Low
Folsom-Natoma St.*					
Sacramento-Bercut Drive			12	41	Low

* Folsom-Natoma St. site was offline due to construction in late July 2019.

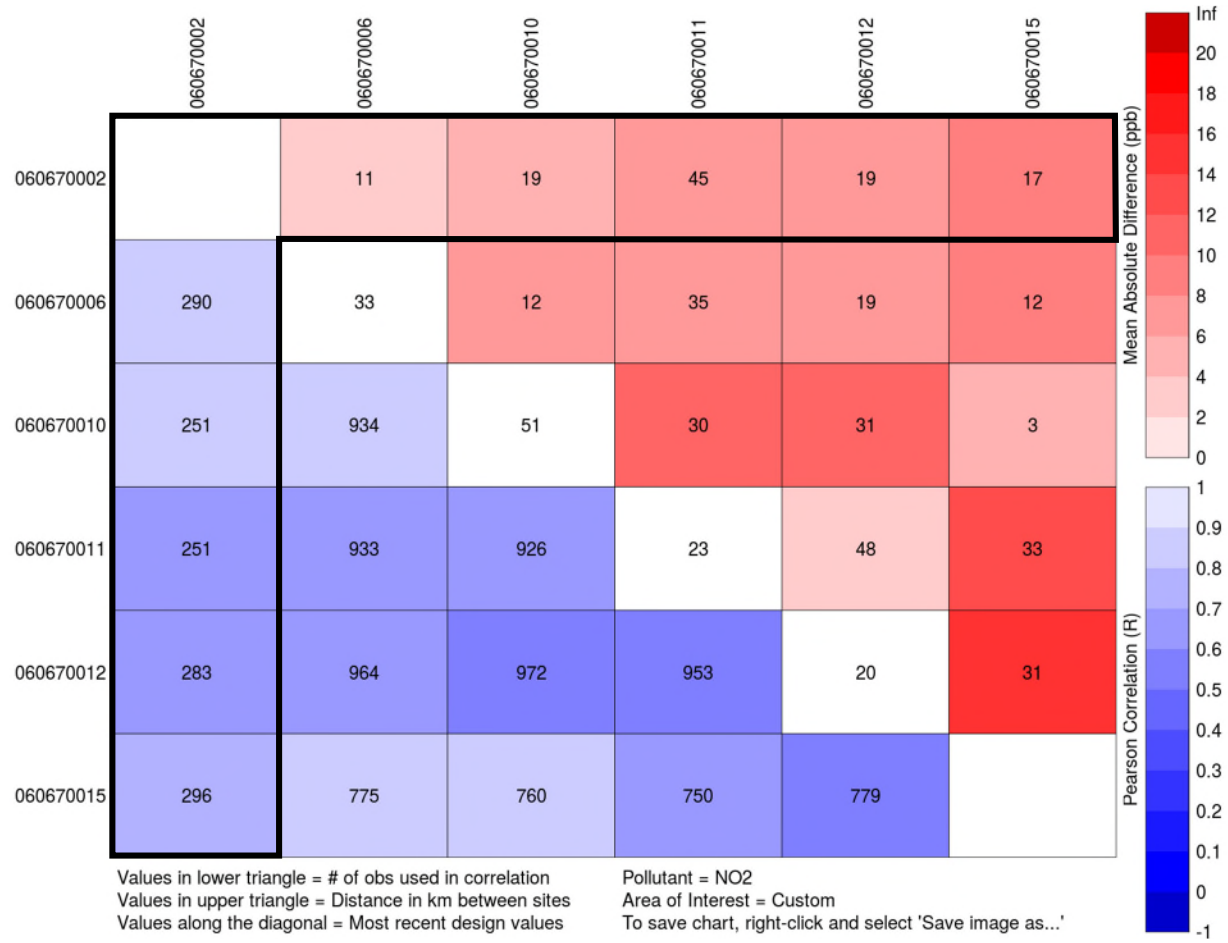
NO_2 Monitor-to-Monitor Correlation Analysis

NO_2 concentrations were compared for redundancy using a correlation matrix analysis. Figure 56 shows a correlation matrix for all NO_2 monitors in Sacramento County provided by the NetAssess2020 v1.1 tool. The raw values from the correlation matrix are shown in Table 55. Included in the matrix are the square of the Pearson correlations (R^2), mean absolute differences, number of observations used in the correlation, distance in kilometers between the sites, and the 2018 design values. The correlation matrix helps to determine sites within the network that can be considered redundant. Sites with high correlation, low absolute difference, and close proximities are considered redundant in this analysis.

Based on thresholds outlined in the Introduction of this document, the criteria for this analysis are as follows:

Monitor Rank	Criteria
High (meets 1 or less of the criteria)	Highest pairwise $R^2 > 0.75$
Medium (meets 2 of the criteria)	Distance between sites < 12 km
Low (meets 3 of the criteria)	Mean Difference < 3.63 ppb

Monitor-to-monitor correlation analysis found that based on R^2 values, only Sacramento-Del Paso Manor and Sacramento-1309 T Street were moderately correlated with each other ($R^2 > 0.75$). All other sites had R^2 values less than 0.75. This lack of correlation between sites highlights the difference in characteristics of the station locations with respect to NO_2 sources (e.g. near-road, background), but also the variability in NO_2 concentrations throughout the county. Based on the mean difference between monitor concentrations, only a single pair of monitors observed a mean difference that meets the criteria for possible redundancy. These monitors are the Elk Grove-Bruceville and Folsom-Natoma monitors. This reinforces the reasoning of the low correlation between sites. The last factor to include in this analysis is the proximity of the stations to each other. In general, sites are more correlated the closer they are together. There are four pairs of sites which meet the criteria for distance between sites. These are North Highlands-Blackfoot and Sacramento-Del Paso Manor, Sacramento-Del Paso Manor and Sacramento-1309 T Street, Sacramento-Del Paso Manor and Sacramento-Bercut Drive, and Sacramento-1309 T Street and Sacramento-Bercut Drive. Every other site in the network is at least 17 km from each other.



060670002 – North Highlands-Blackfoot
060670006 – Sacramento-Del Paso Manor
060670010 – Sacramento-1309 T Street
060670011 – Elk Grove-Bruceville
060670012 – Folsom-Natoma St.
060670015 – Sacramento-Bercut Drive

Figure 56 – Correlation matrix for NO_2 monitors serving Sacramento County (source: NetAssess2020 v1.1). The lower triangle refers to the blue shaded boxes and the upper triangle refers to the red shaded boxes. Most recent design values are for the 2018 design value year. The area within the black box indicates correlations with the North Highlands-Blackfoot monitor.

Table 55 – Monitor to monitor correlation data. **Red and bold** represent conditions considered to be redundant (R^2 > 0.75, distance between sites < 25% of maximum distance between any two sites, mean difference < 25% of maximum mean difference between any two sites). All correlations with the North Highlands-Blackfoot site are italicized.

Site #1	Site #2	Distance Between Sites (km)	Number of Observations	Pearson Correlation	R^2	Mean Difference (µg m^{-3})
NH	*DPM*	***11***	*290*	*0.8265*	*0.683*	*3.8586*
NH	*TST*	*19*	*251*	*0.8364*	*0.700*	*5.1857*
NH	*BRU*	*45*	*251*	*0.6381*	*0.407*	*6.5339*
NH	*FOL*	*19*	*283*	*0.634*	*0.402*	*6.5088*
NH	*BER*	*17*	*296*	*0.7666*	*0.588*	*8.3649*
DPM	TST	**12**	934	0.8843	**0.782**	6.0316
DPM	BRU	35	933	0.6825	0.466	6.0139
DPM	FOL	19	964	0.6593	0.435	6.2905
DPM	BER	**12**	775	0.8271	0.684	8.6026
TST	BRU	30	926	0.6907	0.477	11.0794
TST	FOL	31	972	0.5956	0.355	11.8385
TST	BER	**3**	760	0.8581	0.736	5.3397
BRU	FOL	48	953	0.567	0.321	3.2623
BRU	BER	33	750	0.6577	0.433	13.492
FOL	BER	31	779	0.5316	0.283	14.5366

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor
TST – Sacramento-1309 T Street
BRU – Elk Grove-Bruceville
FOL – Folsom-Natoma St.
BER – Sacramento-Bercut Drive

This monitor-to-monitor correlation analysis shows that no sites in Sacramento County meet all three of the thresholds to being considered as redundant (rank low). The Sacramento-Del Paso Manor and Sacramento-1309 T Street sites are the only sites that meet two of the three criteria with any other site and are ranked as medium in this analysis. All other sites meet one or less of the criteria and are ranked as high importance. The Sacramento-Bercut Drive site is required by EPA as part of the Near Road monitoring network, and Sacramento-Del Paso Manor is required as part of the NCore monitoring network. Therefore, these two sites are unsuitable for removal. The rankings for this analysis are summarized in Table 56.

Table 56 – Monitor-to-monitor correlation ranking.

Station Name	Monitor-to-Monitor Rank
North Highlands-Blackfoot	High
Sacramento-Del Paso Manor	Medium
Sacramento-1309 T Street	Medium
Elk Grove-Bruceville	High
Folsom-Natoma St.	High
Sacramento-Bercut Drive	High

Trend Analysis

Monitors that have a long historical record are valuable for tracking trends. In this analysis, sites are ranked based on the duration of the continuous measurement record as described in the Introduction to this document. The thresholds for this analysis are as follows:

Monitor Rank	Criteria
High	Trend ≥ 30 years
Medium	30 years > Trend ≥ 10 years
Low	Trend < 10 years

Table 57 shows the year that NO_2 measurements began at each of the stations serving Sacramento County. Based on this analysis, North Highlands-Blackfoot and Sacramento-Del Paso Manor have record lengths which meets the threshold outlined in the Introduction to this document to rank as high. Sacramento-1309 T Street, Elk Grove-Bruceville, and Folsom-Natoma all rank as medium importance, and Sacramento-Bercut Drive is the only site that ranks as low in this analysis.

Table 57 – Date of operation for each NO_2 station serving Sacramento County.

Station Name	Begin Year of NO_2 Operation	Trend Rank
North Highlands-Blackfoot	1980	High
Sacramento-Del Paso Manor	1980	High
Sacramento-1309 T Street	1995	Medium
Elk Grove-Bruceville	1992	Medium
Folsom-Natoma St.*	1996	Medium
Sacramento-Bercut Drive	2015	Low

* Folsom-Natoma St. site was offline due to construction in late July 2019.

NO_2 Monitor Removal Bias Analysis

Each monitor was analyzed to determine the change in spatial concentrations interpolated across Sacramento County if the monitor was removed. Table 58 and Figure 57 present the results of the removal bias analysis and the maximum change in NO_2 concentrations in Sacramento County if each NO_2 monitor in the District's network was individually removed as calculated by the NetAssess2020 v1.1 tool.

The change in concentration at a site indicates the bias which may be observed if the individual monitor were removed. Per the Network Assessment Guidance, "[t]he greater the bias, the more important the site is for interpolation." Based on the thresholds outlined in the Introduction to this document, the thresholds for this analysis are as follows, where MRB is the mean relative bias:

Monitor Rank	Criteria	Criteria (NH Removed)
High	|MRB| ≥ 6.6 ppb	|MRB| ≥ 6.6 ppb
Medium	6.6 ppb > |MRB| ≥ 2.2 ppb	6.6 ppb > |MRB| ≥ 2.2 ppb
Low	|MRB| < 2.2 ppb	|MRB| < 2.2 ppb

Folsom-Natoma is the only monitor which meets the threshold for high importance. The North Highlands-Blackfoot, Sacramento-Del Paso Manor, Elk Grove-Bruceville, and Sacramento-Bercut Drive monitors rank as medium importance, and the Sacramento-1309 T Street monitor is the only site that

ranks as low importance in this analysis. The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 58. No changes to the rankings were observed. Results are tabulated in Table 59.

Table 58 – NO_2 monitoring network removal bias results.

		NH Station Removed
Station Name	**Mean Removal Bias (ppb)**	**Mean Removal Bias (ppb)**
North Highlands-Blackfoot	2.5	N/A
Sacramento-Del Paso Manor	3.6	3.9
Sacramento-1309 T Street	-0.2	-0.2
Elk Grove-Bruceville	6.3	6.3
Folsom-Natoma St.	8.8	8.8
Sacramento-Bercut Drive	-4.1	-4.1

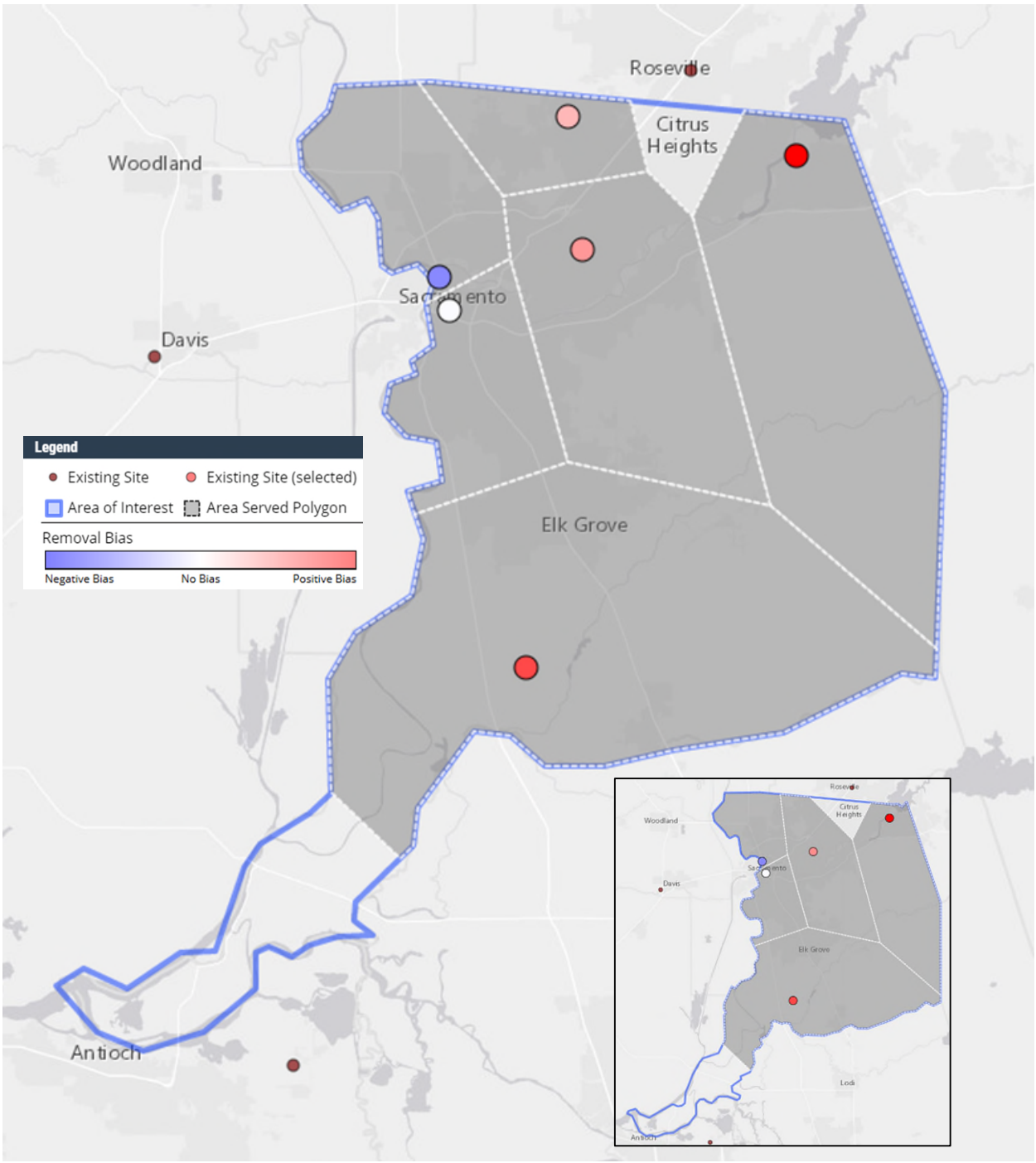


Figure 57 – NO_2 Removal bias analysis in Sacramento County. Inset shows analysis with the North Highlands-Blackfoot station removed.

Table 59 – Removal bias rank.

Station Name	Removal Bias Rank	Removal Bias Rank NH Removed from Analysis
North Highlands-Blackfoot	Medium	
Sacramento-Del Paso Manor	Medium	Medium
Sacramento-1309 T Street	Low	Low
Elk Grove-Bruceville	Medium	Medium
Folsom-Natoma St.	High	High
Sacramento-Bercut Drive	Medium	Medium

NO_2 Minimum Number of Monitors Required

The minimum number of monitors required under Appendix D of 40 CFR Part 58 and number of sites in the Sacramento MSA are listed in Table 60. Note that there are six (6) sites in Sacramento County as shown in Figure 52. Federal regulations require that a minimum of one monitor be placed in any urban area with a population greater than 1,000,000 people to assess area-wide NO_2 concentrations. There are six (6) NO_2 monitoring sites currently operational in the District's network to characterize area-wide NO_2 (BER, BRU, DPM, FOL, NH, TST).

CBSAs with a population above 500,000 are required to place a monitor near a major roadway where maximum concentrations are expected to occur. Additional near-road NO_2 monitoring stations are required for any CBSA with a population of 2,500,000 persons or more, or in a CBSA with a population of 500,000 or more persons that has one or more roadway segments with an AADT count of 250,000 or greater. Sacramento-Bercut Drive became operational in November 2015 and has been sited to meet the population-based microscale near-road NO_2 monitoring requirement in 40 CFR 58, Appendix D, Section 4.3.2.

AADT data for Sacramento County were obtained from the California Department of Transportation[69]. In 2019, an AADT count of 277,000 was registered along State Route 50 near Junction Route 160 between 15th and 16th Street. This traffic count location shows AADT values are greater than the 250,000 AADT threshold presented in 40 CFR 58, Appendix D, Section 4.3.2(a), requiring a second near-road monitoring site to be located within the Sacramento CBSA. However, as of the most recent available 2020 traffic volume data, the maximum AADT count falls below the 250,000 count threshold at 249,000 vehicles along State Route 50 near Junction Route 160 between 15th and 16th Street. The trend in maximum AADT values from 2015 to 2020 is shown in Figure 58. The maximum AADT counts in Figure 58 are all located at the same location, along State Route 50 near Junction Route 160 between 15th and 16th Street. Note that traffic volumes in 2020 appear to be anomalous from the previous 5 years and may have been impacted due to public health orders related to the COVID-19 pandemic.

[69] California Department of Transportation. https://dot.ca.gov/programs/traffic-operations/census

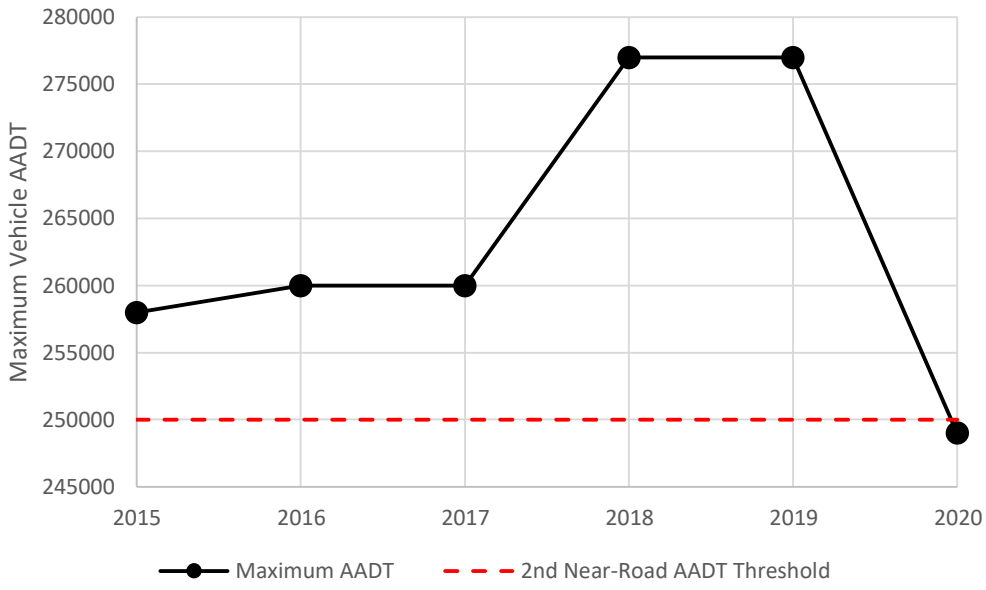


Figure 58 – Maximum annual average daily traffic (AADT) in Sacramento County for the years 2015 to 2020 and the 250,000 vehicles threshold for a second near-road monitoring site per 40 CFR Part 58 Appendix D, 4.3.2(a) (source: California Department of Transportation, CalTrans). All values are located along State Route 50 near Junction Route 160 between 15th and 16th Street.

The District analyzed AADT as well as Fleet Equivalent Annual Average Daily Traffic (FEAADT) in Sacramento County to determine the most appropriate location for near-road monitoring. The location of the highest AADT in 2019 and 2020 was along State Route 50 near Junction Route 160 between 15th and 16th Street. The location of the highest FEAADT in 2019 and 2020 was along Interstate Route 5 near I street. These locations are illustrated in Figure 59. Included in Figure 59 are the locations of the current NO_2 monitoring stations (black), including the current District near-road monitoring site, Sacramento-Bercut Drive (green). The Sacramento-Bercut Drive station was established and located as near as possible to the location of the highest calculated FEAADT in Sacramento County, along Interstate 5 near I Street (blue square). The highest truck AADT counts from the most recent 2020 data are located along the I-5 corridor through Sacramento (greater than the 95th percentile, red dots). This data indicates that the Sacramento-Bercut Drive station is measuring NO_2 concentrations corresponding to the highest truck traffic in Sacramento County. This is important as heavy-duty trucks comprise nearly a third of California statewide NOx emissions, whereas light-duty and medium-duty vehicles combined make up just over a tenth of those same emissions[70].

[70] California Air Resources Board, 2020. https://ww2.arb.ca.gov/news/california-adopts-strong-new-regulation-further-reduce-smog-forming-pollution-heavy-duty

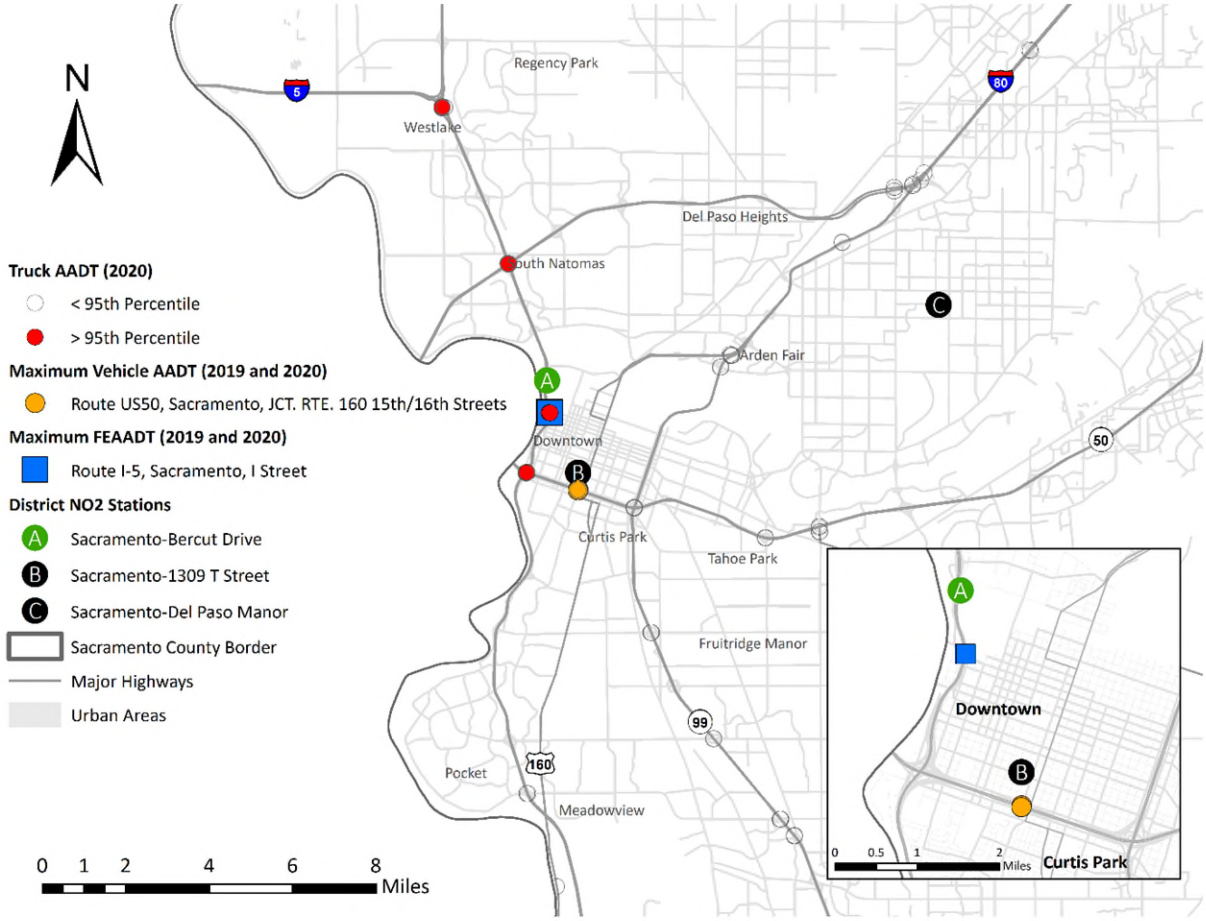


Figure 59 – Locations of greater than the 95th percentile of 2020 truck annual average daily traffic (AADT) (red dots), maximum vehicle AADT (orange dot), maximum fleet equivalent AADT (FEAADT; blue square), District NO_2 monitoring stations (black dots), the District near-road site (green dot), and the major highways within Sacramento County (AADT source: California Department of Transportation, CalTrans).

The highest total traffic volume is located along US50 (orange dot) near the downtown core of Sacramento. As shown in Figure 60, truck traffic makes up 2.3% of the total vehicle traffic at the US50 location as opposed to 9.6% of the total vehicle traffic at the I-5 location. This difference in traffic composition could lead to lower measured NO_2 concentrations at the US50 location than from the I-5 location even with the increased total vehicle AADT. The Sacramento-T Street site (site B in Figure 59) is located less than a third of a mile from the US50 location and is in a residential portion of the downtown urban core. This site may help to provide preliminary information on population impacts and NO_2 concentrations from the highest AADT in the county.

To help determine if a second near-road station is appropriate, the Sacramento-T Street site may be suitable for preliminary near-road NO_2 analysis. As discussed in the Measured Concentration and Exceedance Probability section of this section, NO_2 design values in Sacramento County, including the near-road Sacramento-Bercut Drive site, all fall well below the NAAQS. This and the proximity of the Sacramento-T Street station to the highest AADT count in Sacramento County suggest that preliminary analysis at this station could be insightful before undertaking the heavy investment in resources and

funding required to locate, install, and operate a second near-road station. The District will continue to monitor traffic count data and will continue to work with EPA and CARB to determine the appropriate timing, location, and funding for a second near-road monitoring site if necessary.

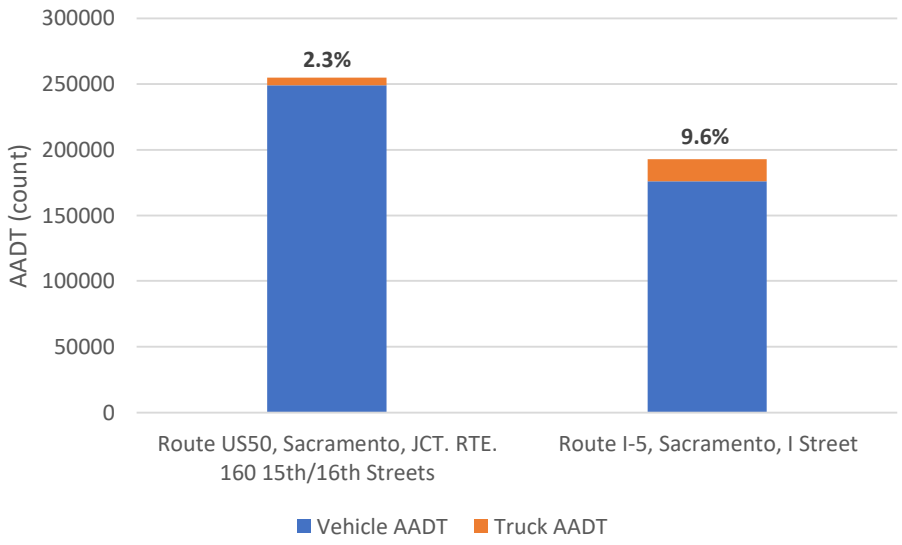


Figure 60 – 2020 vehicle and truck annual average daily traffic along State Route 50 near Junction Route 160 between 15th and 16th Street and along Interstate 5 near I Street in Sacramento (source: California Department of Transportation, CalTrans).

Table 60 – Minimum monitoring requirements within Sacramento MSA.

Type	Sites Required	Sites in Sacramento MSA	Additional Sites Needed
Area-wide	1	6	0
Near-road	2*	1	1*

* Sacramento MSA has surpassed the 250,000 vehicles threshold for a second near-road monitoring site per 40 CFR Part 58 Appendix D, 4.3.2(a) using 2019 traffic volumes from the California Department of Transportation. From the most recent 2020 traffic volumes, Sacramento MSA falls below this threshold with a maximum vehicle AADT of 249,000 on State Route 50 near Junction Route 160 between 15th and 16th Street. The District is working with EPA and CARB to determine the appropriate timing, location, and funding for a second near-road monitoring site if necessary.

Conclusions

Table 61 is a summary of the District's NO_2 monitor rankings from the analyses performed in this section. An overall ranking was calculated for each site by assigning a value to each rank (1 – low, 2 – medium, 3 – high) and summing over all analyses.

Table 61 – NO_2 monitor ranking summary. Overall score is shaded red, with highest overall score darkest.

Station Name	Population-Served	Area-Served	Measured Concentrations	Deviation from NAAQS*	Monitor-to-Monitor	Trend	Removal Bias	Overall
North Highlands-Blackfoot	Low	Low	Low		High	High	Medium	11
Sacramento-Del Paso Manor	High	Medium	Low	Low	Medium	High	Medium	14
Sacramento-1309 T Street	High	Low	Low	Low	Medium	Medium	Low	11
Elk Grove-Bruceville	Medium	High	Low	Low	High	Medium	Medium	14
Folsom-Natoma St.	Low	High	Low		High	Medium	High	13
Sacramento-Bercut Drive	Low	Low	Low	Low	High	Low	Medium	10
North Highlands-Blackfoot Removed from Analysis								
Sacramento-Del Paso Manor	High	Medium	Low	Low	Medium	High	Medium	14
Sacramento-1309 T Street	High	Low	Low	Low	Medium	Medium	Low	11
Elk Grove-Bruceville	Medium	High	Low	Low	High	Medium	Medium	14
Folsom-Natoma St.	Low	High	Low		High	Medium	High	13
Sacramento-Bercut Drive	Low	Low	Low	Low	High	Low	Medium	10

* For the NO_2 analysis, the 1-hr and annual standards were combined to minimize bias in the overall score due to limited valid design value calculations.

Based on Table 61, the Elk Grove-Bruceville and Sacramento-Del Paso Manor monitors are the highest overall ranked and therefore most important sites for NO_2. Sacramento-Bercut Drive is ranked as the lowest of the monitors. The discontinuation of the North Highlands-Blackfoot station yielded no change to the rankings. This analysis shows that if a replacement station is installed near the previous location of the North Highlands-Blackfoot site, measured concentrations within Sacramento County are far from exceeding the NAAQS, even at the near-road Sacramento-Bercut Drive site, therefore a replacement NO_2 monitor is not necessary at this new location.

For this analysis, the overall total can be misleading. It appears as though the least important monitor in the network is the dedicated near-road Sacramento-Bercut Drive site. This analysis takes factors into account which lessen the site's perceived importance, such as the site is located close to another downtown location (Sacramento-1309 T Street), which lowers the importance in the population-served, area-served, and removal bias analyses, and was the most recently installed monitor lowering the trend rank as well. However, what these analyses do not take into account is that the Sacramento-Bercut Drive site is part of the Near Road network and is specifically designed to sample the highest concentrations of NO_2, which involves sampling very close to a highly trafficked roadway. The highest

calculated FEAADT in Sacramento County is located at I Street and Interstate 5, within 1 km distance of the Sacramento-Bercut Drive station[71]. Therefore, as this site was installed after many of the other long-term stations in the District network were already established, it has a data-driven specific location to sample. The location next to a busy freeway bears out in the measured concentrations at the site, as it indeed has the highest annual design values and samples the highest hourly concentrations in the county[72]. However, the design values are still below the federal standards and thus the ranking of this site is low in the deviation from NAAQS analysis as well. As the location of this site was specifically chosen to sample near the highest FEAADT in the county, an important characteristic of the site is that it provides important public information and data for research purposes. Given the reasoning above as well as being required as part of the near road monitoring network, the Sacramento-Bercut Drive location is not suitable for removal or relocation. As the design values are far from exceeding the standard in Sacramento County, it is not recommended that new sites be included in the District network. However, due to Sacramento MSA exceeding the threshold for a second near-road monitoring site according to 40 CFR Part 58 (with the exception of 2020 traffic volume as described earlier), the District is working with EPA and CARB to determine the appropriate timing, location, and funding for a second near-road monitoring site if necessary.

In conclusion, the current NO_2 network for Sacramento County meets all federal requirements except for the addition of a second near-road station. The network adequately meets District monitoring objectives. There are no sites in Sacramento County recommended for removal.

[71] Estimated FEAADT is 588,557 vehicles at Sacramento-I Street using 2019 annual average daily truck traffic (source: California Department of Transportation) and EMFAC2017 v1.0.2 emission inventories.

[72] The Sacramento-Bercut Drive site had monitor malfunctions leading to unmet annual completeness requirements per 40 CFR Part 58 Appendix D (source: station logs and data certification letters). As the hourly design value is a three year average, there was no valid hourly design value for the assessment period.

Carbon Monoxide (CO) Network Analysis

Monitoring Objectives

The largest ambient atmospheric sources of carbon monoxide (CO) are cars, trucks and other vehicles or machinery that burn fossil fuels. Indoor sources can include unvented kerosene and gas space heaters, leaking chimneys and furnaces, and gas stoves[73]. Most emissions of CO in Sacramento County according to the 2017 EPA National Emissions Inventory[74] are from mobile sources as seen in Figure 61.

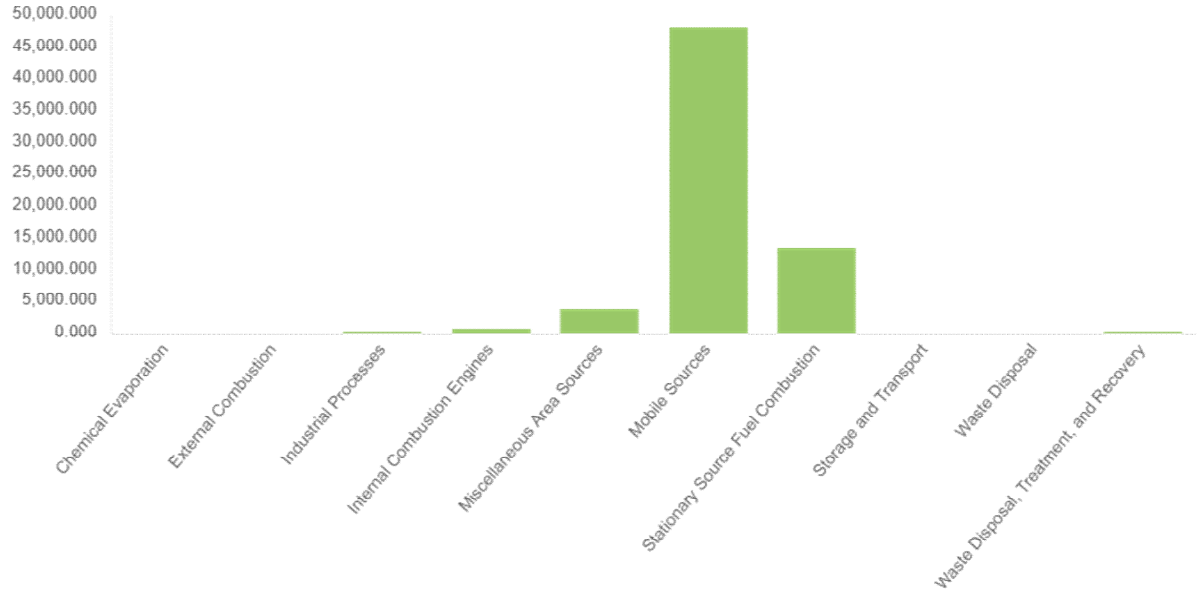


Figure 61 – Total CO emissions in tons by process in Sacramento County as per the 2017 EPA National Emissions Inventory (source: EPA NEI).

Sacramento County has a total of two (2) active SLAMS CO monitoring stations as shown in Figure 62. The North Highlands-Blackfoot station as discussed in the Recent Notable Modifications to the Network section was discontinued after the assessment period. Based on the characteristics of the sites, including the population served and the area served, each site can be designated as background, population oriented, source oriented, or high concentration monitoring locations as listed in Table 62.

[73] https://www.epa.gov/indoor-air-quality-iaq/carbon-monoxides-impact-indoor-air-quality
[74] https://gispub.epa.gov/neireport/2017/

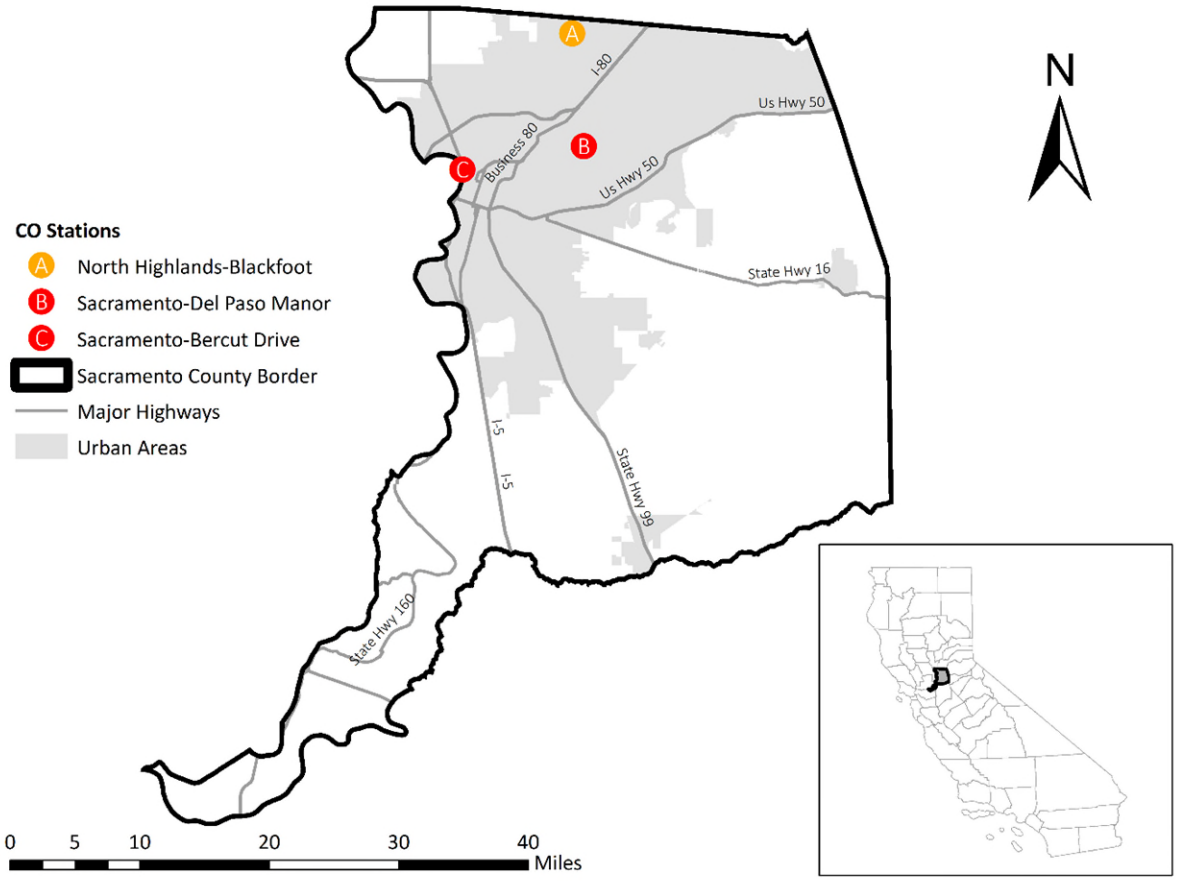


Figure 62 – CO Network in Sacramento County. Orange marker indicates an inactive monitor or discontinued station.

Table 62 – Monitoring objective for CO monitors serving Sacramento County.

Site	EPA Network Affiliation*	Monitoring Objective**
North Highlands-Blackfoot	SPM	Population Oriented
Sacramento-Del Paso Manor	NCORE/PAMS	Population Oriented
Sacramento-Bercut Drive	Near Road	Source Oriented

Note: All monitors are SLAMS (State and Local Air Monitoring Stations) monitor type unless otherwise noted.
* NCORE (National Core Multi-pollutant Monitoring Stations), SPM (Special Purpose Monitor not part of SLAMS), PAMS (Photochemical Assessment Monitoring Station).
** These objectives are consistent with EPA monitoring types as listed in 40 CFR Part 58, Appendix D.

In 2011, EPA retained the existing CO 1-hr NAAQS at a level of 35 parts per million (ppm) measured over 1 hour and retained the CO 8-hr NAAQS at a level of 9 ppm measured over 8 hours. The design value for the 1-hr and the 8-hr NAAQS are not to be exceeded more than once per year. In 2016, the Sacramento region completed the 20-year maintenance period as required by the Clean Air Act and fully reached the attainment classification for CO standard (70 FR 71776).

The District submitted a letter to EPA for the discontinuation of the CO monitor at North Highlands-Blackfoot, and it was approved by EPA on April 20, 2020. The District discontinued the CO monitor on May 20, 2020. The North Highlands-Blackfoot monitor is included in this analysis as the removal was after the 2019 data year.

CO Network Area- and Population-Served Analyses

Spatial analysis techniques were evaluated to determine whether the current CO stations meet the objectives of the monitoring network. Thiessen polygons, as described previously, were generated by the NetAssess2020 v1.1 tool to determine the spatial representation of each of the three (3) CO monitoring stations located in Sacramento County. The following sections present the findings for area- and population-served analyses for the CO network. Note that as seen in Table 62, some of the CO stations are affiliated with EPA networks and are therefore required regardless of these analyses.

The population within Sacramento County represented by each monitoring site was counted within the Thiessen polygons by NetAssess2020 v1.1 using 2010 US Census data. Area- and population-served analyses are presented in Table 63. Figure 63 presents a map showing the location and area of influence for each CO monitor.

Following the methods outlined in the Network Assessment Guidance and the thresholds described in the Introduction to this document, the Sacramento-Del Paso Manor site was ranked as high importance for CO based on an area of influence exceeding 500 km^2. Sacramento-Bercut Drive meets the 250 km^2 threshold for medium importance, and North Highlands-Blackfoot ranks as low importance in this analysis. Sacramento-Del Paso Manor and Sacramento-Bercut Drive serve the most populous portions of Sacramento County and exceed the threshold of 317,000 persons and are therefore both ranked as high importance in this analysis. North Highlands-Blackfoot meets the 159,000 persons threshold and is ranked as medium importance for this analysis. The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 63. No changes to rankings were observed. Site rankings are summarized in Table 63.

Table 63 – Area and population served by CO monitors serving Sacramento County. Darker red indicates the highest values and therefore the most importance.

Station Name	Population Estimate (persons)	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
North Highlands-Blackfoot	247,005	180	Medium	Low
Sacramento-Del Paso Manor	602,870	1426	High	High
Sacramento-Bercut Drive	539,045	482	High	Medium

North Highlands-Blackfoot Removed from Analysis

Station Name	Population Estimate (persons)	Area (km^2)*	Population-Served Ranking	Area-Served Ranking
Sacramento-Del Paso Manor	840,415	1590	High	High
Sacramento-Bercut Drive	548,505	498	High	Medium

* Population and area estimates based on monitor's area of influence and an approximate boundary of Sacramento County as extracted from the NetAssess2020 v1.1 tool. Population estimated with some overlapping census tracts.

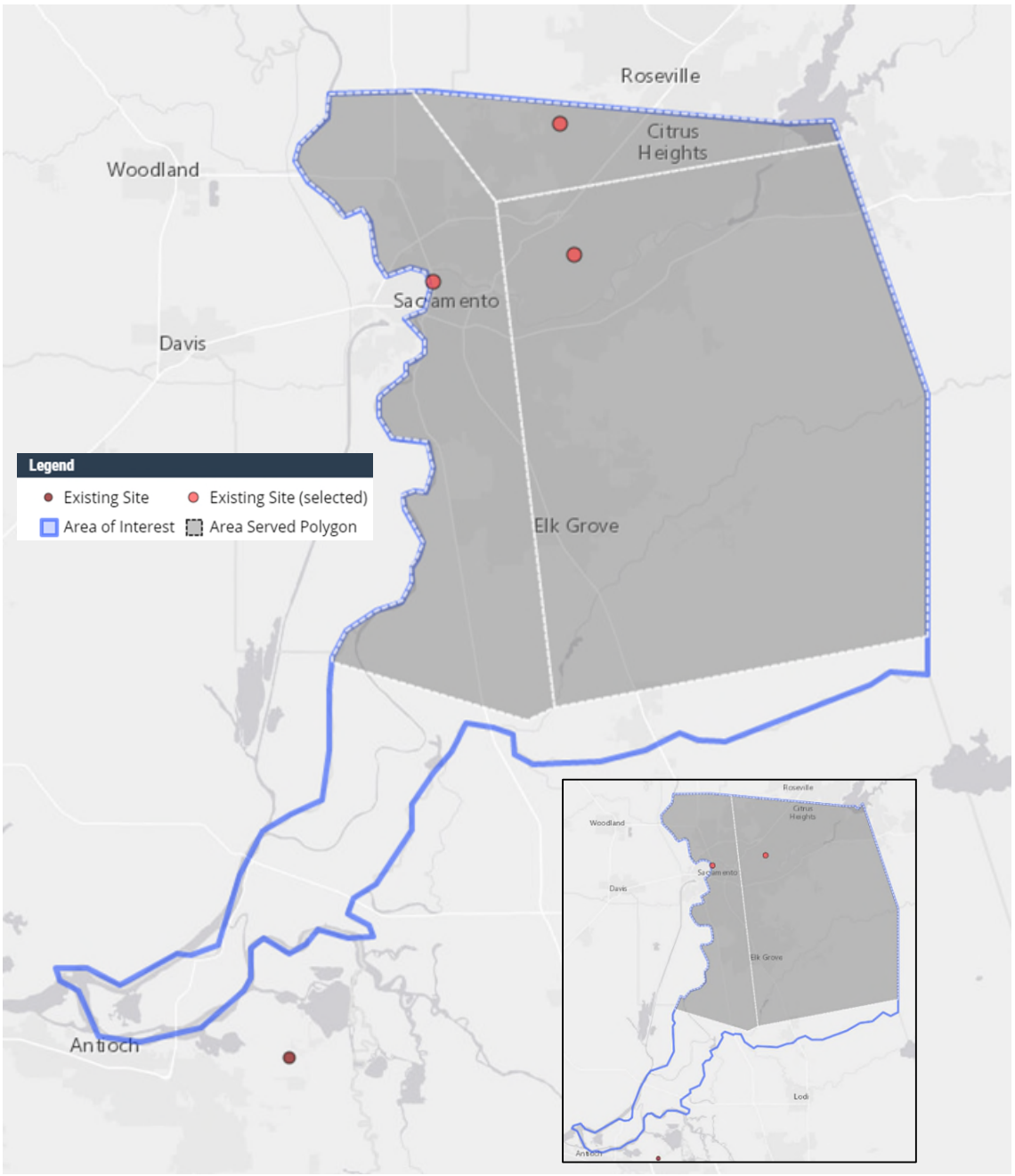


Figure 63 – CO network area-served. Inset shows analysis with the North Highlands-Blackfoot station removed.

CO Data Analyses

The CO data analysis conducted was used to determine the importance of a site based on the following methods:

- measured concentrations and exceedance probability,
- deviation from NAAQS,
- monitor-to-monitor correlation,
- trend impact, and
- removal bias.

Measured Concentration and Exceedance Probability

Monitors within the District's ambient air monitoring network were shown to have high levels of CO, design values close to the standard, and with long historical record were considered to be of high value for characterizing pollution in an area. Table 64 presents 1-hour and 8-hour CO design value concentrations for 2010 through 2019 (2010-2014 data included for historical context). The exceedance probability was not calculated in the NetAssess2020 v1.1 tool and is therefore not included in this analysis. However, for contextual purposes, as part of the monitor discontinuation process at the North Highlands-Blackfoot site in 2019, the monitor was shown and approved by EPA to have a probability of less than 10% of exceeding 80% of both the 1-hr and 8-hr NAAQS during the next three years based on the levels, trends, and variability observed in the past[75].

Table 64 – Concentration analysis for CO monitors serving Sacramento County (source: EPA AQS).

Station Name	Valid 1-hr CO Design Value (ppb)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NH	2.1	2.2	2.2	2.1	1.7	1.8	2.1	2.1	4.1	4.1
DPM	3.0	2.5	2.5	2.4	2.3	2.2	2.4	2.4	3.9	3.9
BER*							1.6	1.6	3.1	3.1
Station Name	**Valid 8-hour CO Design Value (ppb)**									
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
NH	1.6	1.7	1.7	1.5	1.2	1.3	1.6	1.6	3.6	3.6
DPM	2.2	2.2	2.2	2.1	2.1	1.9	1.9	1.7	3.3	3.3
BER*						0.9	1.3	1.3	2.4	2.4

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor
BER – Sacramento-Bercut Drive
* Sacramento-Bercut Drive came online October 2015.

[75] US EPA, Region 9 (2020), Letter to Sacramento Metropolitan Air Quality Management District. 20 April 2020. Print.

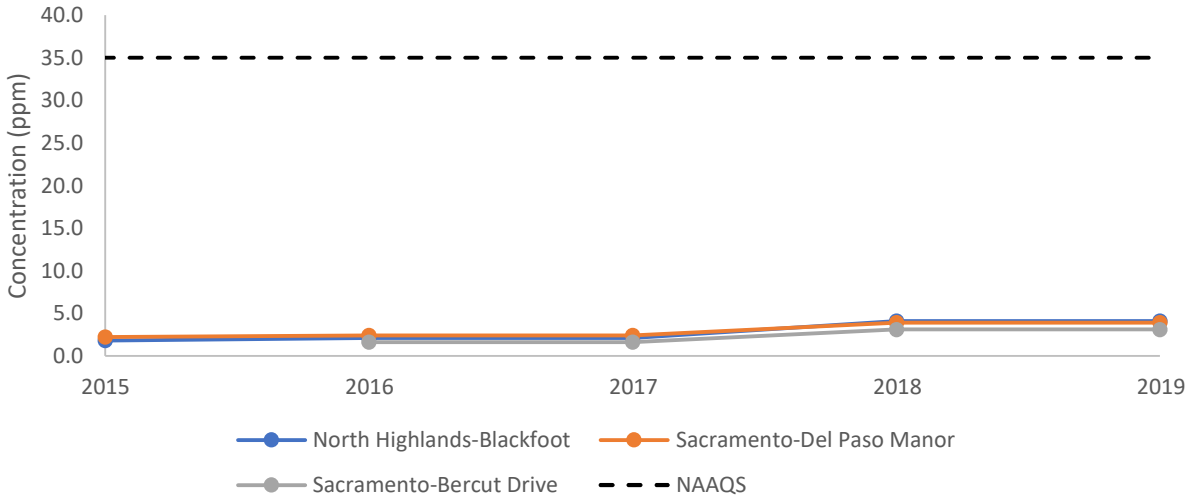


Figure 64 – 1-hr CO concentration trend (Source: EPA AQS).

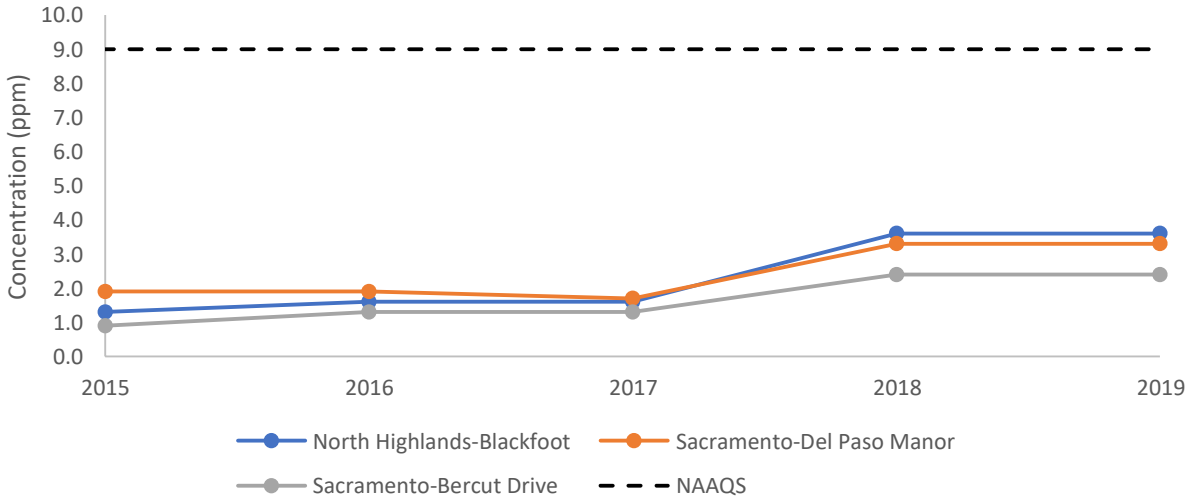


Figure 65 – 8-hr CO concentration trend (Source: EPA AQS).

Figure 64 and Figure 65 present the 2015 through 2019 valid design values for CO monitors serving Sacramento County. Per the introduction to this document, sites were ranked based on the average concentrations used to determine the design value (DV_{ave}) for the assessment period (2015-2019). The thresholds for this analysis used the 24-hour NAAQS and are as follows:

Monitor Rank	Criteria
High	$DV_{ave} > 35$ ppm
Medium	35 ppm $\geq DV_{ave} \geq 31.5$ ppm
Low	$DV_{ave} < 31.5$ ppm

Following the thresholds outlined in the Introduction to this document, no monitors meet the thresholds for high or medium importance for this analysis for either the 1-hour or 8-hour NAAQS. All monitors are ranked as low importance. The rankings are tabulated in Table 65.

Table 65 – Measured concentrations ranking.

Station Name	Measured Concentrations
North Highlands-Blackfoot	Low
Sacramento-Del Paso Manor	Low
Sacramento-Bercut Drive	Low

Deviation from NAAQS

The thresholds for this analysis, as outlined in the Introduction to this document, use the 1-hour and 8-hour NAAQS and are as follows:

Monitor Rank	Criteria (1-hour)	Criteria (8-hour)
High	|Deviation| < 3.5 ppm	|Deviation| < 0.9 ppm
Medium	3.5 ppm ≥ |Deviation| ≥ 7 ppm	0.9 ppm ≥ |Deviation| ≥ 1.8 ppm
Low	|Deviation| > 7 ppm	|Deviation| > 1.8 ppm

As shown in Table 66, the deviation from NAAQS analysis shows for both the 1-hr and the 8-hour NAAQS, all sites having values exceeding 20% of the NAAQS (7 ppm and 1.8 ppm respectively). This corresponds to the lowest ranking based on the Network Assessment Guidance that "[s]ites measuring concentrations (design values) that are very close to the NAAQS exceedance threshold are ranked highest in this analysis." Following the thresholds described in the Introduction to this document, all monitors are ranked as low importance for this analysis for both NAAQS.

Table 66 – 2019 1-hr and annual CO design value and deviation from NAAQS analysis.

Station Name	2019 1-hr CO Design Value (ppm)	Deviation from 1-hr NAAQS (ppm)	Ranking	2019 8-hr CO Design Value (ppm)	Deviation from Annual NAAQS (ppm)	Ranking
North Highlands-Blackfoot	4.1	30.9	Low	3.6	5.4	Low
Sacramento-Del Paso Manor	3.9	31.1	Low	3.3	5.7	Low
Sacramento-Bercut Drive	3.1	31.9	Low	2.4	6.6	Low

* Folsom-Natoma St. site was offline due to construction in late July 2019.

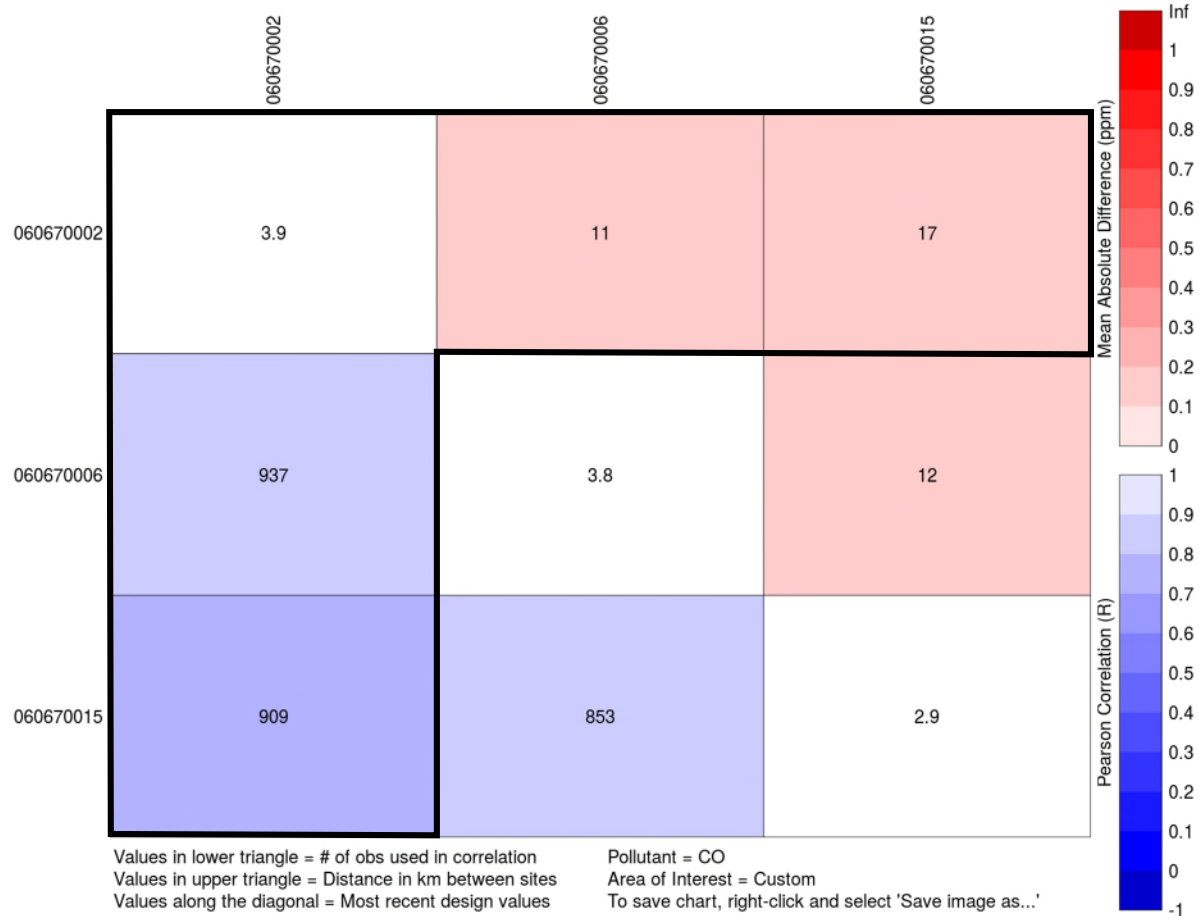
CO Monitor-to-Monitor Correlation Analysis

CO concentrations were compared for redundancy using a correlation matrix analysis. Figure 66 shows a correlation matrix for all CO monitors in Sacramento County provided by the NetAssess2020 v1.1 tool. The raw values from the correlation matrix are shown in Table 67. Included in the matrix are the square of the Pearson correlations (R^2), mean absolute differences, number of observations used in the correlation, distance in kilometers between the sites, and the 2018 design values. The correlation matrix helps to determine sites within the network that can be considered redundant. Sites with high correlation, low absolute difference, and close proximities are considered redundant in this analysis.

Based on thresholds outlined in the Introduction of this document, the criteria for this analysis are as follows:

Monitor Rank	Criteria
High (meets 1 or less of the criteria)	Highest pairwise $R^2 > 0.75$
Medium (meets 2 of the criteria)	Distance between sites < 4 km
Low (meets 3 of the criteria)	Mean Difference < 0.039 ppm

Monitor-to-monitor correlation analysis found that based on R^2 values, only the North Highlands-Blackfoot and Sacramento-Del Paso Manor monitor pair were moderately correlated with each other ($R^2 > 0.75$). All other sites had R^2 values less than 0.75. The lack of correlation in CO values is possibly due to small fluctuations in low numbers as can be seen by the low mean differences. No monitor pair met the criteria for the mean difference. The last criteria in this analysis was the proximity of the stations to each other. No sites met the criteria for proximity.



060670002 – North Highlands-Blackfoot
060670006 – Sacramento-Del Paso Manor
060670015 – Sacramento-Bercut Drive

Figure 66 – Correlation matrix for CO monitors serving Sacramento County (source: NetAssess2020 v1.1). The lower triangle refers to the blue shaded boxes and the upper triangle refers to the red shaded boxes. Most recent

design values are for the 2018 design value year. The area within the black box indicates correlations with the North Highlands-Blackfoot monitor.

Table 67 – Monitor to monitor correlation data. **Red and bold** represent conditions considered to be redundant (R^2 > 0.75, distance between sites < 25% of maximum distance between any two sites, mean difference < 25% of maximum mean difference between any two sites). All correlations with the North Highlands-Blackfoot site are italicized.

Site #1	Site #2	Distance Between Sites (km)	Number of Observations	Pearson Correlation	R^2	Mean Difference (ppm)
NH	*DPM*	*11*	*937*	*0.871*	***0.759***	*0.1577*
NH	*BER*	*17*	*909*	*0.7478*	*0.559*	*0.1542*
DPM	BER	12	853	0.8497	0.722	0.1345

NH – North Highlands-Blackfoot
DPM – Sacramento-Del Paso Manor
BER – Sacramento-Bercut Drive

This monitor-to-monitor correlation analysis shows that no sites meet the thresholds for low or medium rank (2 or less of the criteria met at a single site). Therefore, all three sites rank as high for this analysis. It can be noted that a level of uniqueness is to be expected with only three monitors. However, as mentioned previously, due to factors in addition to the findings in this assessment, the discontinuation of the North Highlands-Blackfoot CO monitor was approved by EPA and has been discontinued as of May 2020. The Sacramento-Del Paso Manor is required as part of the NCore monitoring network and is therefore unsuitable for removal. The rankings for this analysis are summarized in Table 68.

Table 68 – Monitor-to-monitor correlation ranking.

Station Name	Monitor-to-Monitor Rank
North Highlands-Blackfoot	High
Sacramento-Del Paso Manor	High
Sacramento-Bercut Drive	High

Trend Analysis

Monitors that have a long historical record are valuable for tracking trends. In this analysis, sites are ranked based on the duration of the continuous measurement record as described in the Introduction to this document. The thresholds for this analysis are as follows:

Monitor Rank	Criteria
High	Trend ≥ 30 years
Medium	30 years > Trend ≥ 10 years
Low	Trend < 10 years

Table 69 shows the year that CO measurements began at each of the stations serving Sacramento County. Based on this analysis, all sites except Sacramento-Bercut Drive are ranked as high importance.

Table 69 – Date of operation for each CO station serving Sacramento County.

Station Name	Begin Year of CO Operation	Trend Rank
North Highlands-Blackfoot	1980	High
Sacramento-Del Paso Manor	1981	High
Sacramento-Bercut Drive	2015	Low

CO Monitor Removal Bias Analysis

Each monitor was analyzed to determine the change in spatial concentrations interpolated across Sacramento County if the monitor was removed. Table 70 and Figure 67 present the results of the removal bias analysis and the maximum change in CO concentrations in Sacramento County if each CO monitor in the District's network was individually removed as calculated by the NetAssess2020 v1.1 tool.

The change in concentration at a site indicates the bias which may be observed if the individual monitor were removed. Per the Network Assessment Guidance, "[t]he greater the bias, the more important the site is for interpolation." Based on the thresholds outlined in the Introduction to this document, the thresholds for this analysis are as follows, where MRB is the mean relative bias:

Monitor Rank	Criteria	Criteria (NH Removed)
High	|MRB| ≥ 0.083 ppm	|MRB| ≥ 0.015 ppm
Medium	0.083 ppm > |MRB| ≥ 0.028 ppm	0.015 ppm > |MRB| ≥ 0.005 ppm
Low	|MRB| < 0.028 ppm	|MRB| < 0.005 ppm

Rankings for this analysis follow the thresholds outlined above and mean removal biases as shown in Table 70. North Highlands-Blackfoot is the only monitor which meets the threshold for high importance. The Sacramento-Del Paso Manor and Sacramento-Bercut Drive monitors rank as medium importance. No monitors rank as low importance in this analysis. After the discontinuation of the North Highlands-Blackfoot station and MRB recalculated, Sacramento-Del Paso Manor was ranked as medium and Sacramento-Bercut Drive was ranked as high importance for this analysis. Note that the absolute MRB values were reduced with the updated calculation (0.01 and -0.02 ppm, respectively; Table 70), thus impacting the criteria by ranking sites higher importance with lower MRB than prior to removing North Highlands-Blackfoot from the calculations. The analysis was recalculated after the discontinuation of the North Highlands-Blackfoot station and is summarized in Table 71. Minor changes to rankings were observed as Sacramento-Bercut Drive increased rank from medium to high. Note that the absolute values of the bias concentrations are actually closer to zero, indicating a lower bias to the overall system. Results are tabulated in Table 71.

Table 70 – CO monitoring network removal bias results.

		NH Station Removed
Station Name	Mean Removal Bias (ppm)	Mean Removal Bias (ppm)
North Highlands-Blackfoot	-0.11	N/A
Sacramento-Del Paso Manor	0.06	0.01
Sacramento-Bercut Drive	0.04	-0.02

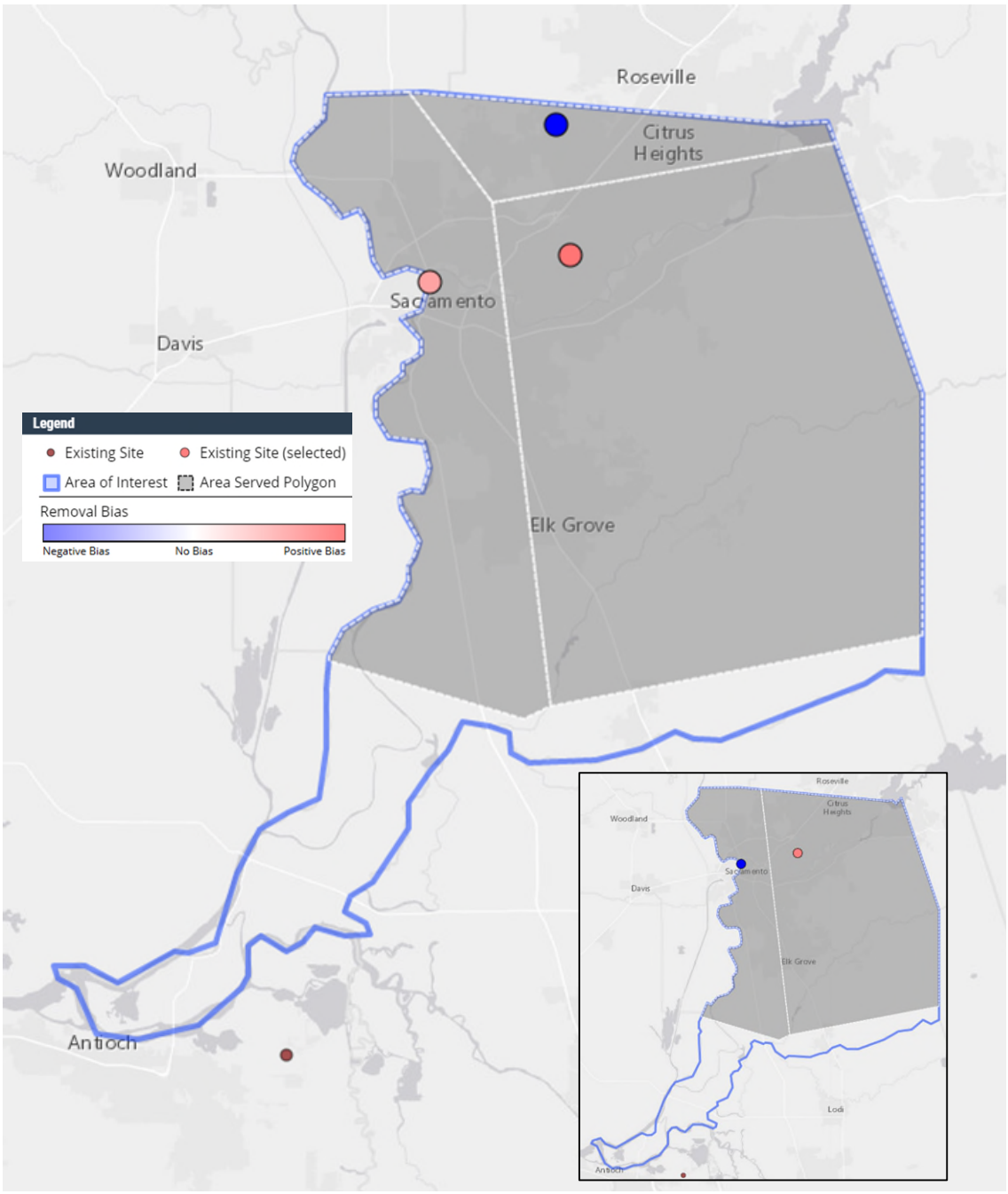


Figure 67 – CO Removal bias analysis in Sacramento County. Inset shows analysis with the North Highlands-Blackfoot station removed.

Table 71 – Removal bias rank.

Station Name	Removal Bias Rank	Removal Bias Rank NH Removed from Analysis
North Highlands-Blackfoot	High	
Sacramento-Del Paso Manor	Medium	Medium
Sacramento-Bercut Drive	Medium	High

CO Minimum Number of Monitors Required

The minimum number of monitors required under Appendix D of 40 CFR Part 58 and number of sites in the Sacramento MSA are listed in Table 72. Note that there are three (3) sites in Sacramento County as shown in Figure 62, however as explained previously, the North Highlands-Blackfoot monitor has been discontinued. One CO monitor is required to operate co-located with a required near-road NO_2 monitor in CBSAs having populations greater than 1,000,000. In addition, NCore sites are required to monitor CO. During this assessment period, the District operated three (3) CO monitoring locations (DPM, NH, BER). As discussed, the District is required to have a second near-road monitor that includes operation of a CO monitor.

Table 72 – Minimum monitoring requirements within Sacramento MSA.

Type	Sites Required	Sites in Sacramento MSA	Additional Sites Needed
Non-near-road	1	1*	0
Near-road	2**	1	1

* This count reflects the discontinuation of the North Highlands-Blackfoot CO monitor.
** 40 CFR Part 58 requires state or local air monitoring organizations to operate a second near-road monitoring site if any traffic count in the metropolitan area surpasses 250,000 in annual average daily traffic. Sacramento MSA has surpassed the threshold and triggered the requirement. The location of the area that surpassed the traffic count threshold is on U.S. Highway 50 east of 15th/16th Street. The District is working with U.S. EPA and CARB to determine the appropriate timing, location, and funding for a second near-road monitoring site.

Conclusions

Table 73 is a summary of the District's CO monitor rankings from the analyses performed in this section. An overall ranking was calculated for each site by assigning a value to each rank (1 – low, 2 – medium, 3 – high) and summing over all analyses.

Table 73 – CO monitor ranking summary. Overall score is shaded red, with highest overall score darkest.

Station Name	Population-Served	Area-Served	Measured Concentrations	Deviation from 1-hour NAAQS	Deviation from 8-hour NAAQS	Monitor-to-Monitor	Trend	Removal Bias	Overall
North Highlands-Blackfoot	Medium	Low	Low	Low	Low	High	High	High	**15**
Sacramento-Del Paso Manor	High	High	Low	Low	Low	High	High	Medium	**17**
Sacramento-Bercut Drive	High	Medium	Low	Low	Low	High	Low	Medium	**14**
North Highlands-Blackfoot Removed from Analysis									
Sacramento-Del Paso Manor	High	High	Low	Low	Low	High	High	Medium	**17**
Sacramento-Bercut Drive	High	Medium	Low	Low	Low	High	Low	High	**15**

Based on Table 73, the Sacramento-Del Paso Manor site is the highest overall ranked and therefore most important site for CO. Sacramento-Bercut Drive is ranked the lowest of the sites. The discontinuation of the North Highlands-Blackfoot station yielded no change to the rankings.

As mentioned previously, the North Highlands-Blackfoot monitor has been discontinued due to reasons mentioned in this analysis as well as independent analysis by EPA in the discontinuation process. The North Highlands-Blackfoot CO SPM is not specifically required by an attainment or maintenance plan, therefore discontinuance will not prevent the District from meeting 40 CFR 58 Appendix D requirements. This analysis shows that if a replacement station is installed near the previous location of the North Highlands-Blackfoot site, measured concentrations within Sacramento County are far from exceeding the NAAQS and all Federal requirements are met, therefore a replacement CO monitor is not necessary at this new location.

Given that the CO design values are far from exceeding the federal standards, and sites are currently located near the highest emission sources consistent with Figure 61, it is not recommended that new sites be included in the District network. The Sacramento-Del Paso Manor and Sacramento-Bercut Drive monitors are required as part of the NCORE and Near Road networks, respectively, and are therefore unsuitable for removal.

In conclusion, the current CO network for Sacramento County meets all federal requirements except for the addition of a near-road CO monitor at the required second Near Road station as outlined in more detail in the NO_2 section. The network adequately meets District monitoring objectives. There are no sites in Sacramento County recommended for removal.

Lead (Pb) Network Analysis

Monitoring Objectives

Sources of lead emissions vary from one area to another. In general, in the United States, major sources of atmospheric lead are ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other sources include waste incinerators, utilities, and lead-acid battery manufacturers. The highest air concentrations of lead are usually found near lead smelters. As a result of EPA's regulatory efforts to remove lead from motor vehicle gasoline, levels of lead in the air decreased by 89 percent between 1980 and 2010[76].

Sacramento County had one (1) SLAMS lead (Pb) monitoring station, Sacramento-Del Paso Manor, during this assessment period as shown in Figure 68. Based on the characteristics of this site, it is designated as population oriented (see Table 74). Rankings are not included in this analysis as there is only a single Pb monitoring site.

[76] https://www.epa.gov/lead/lead-outdoor-air

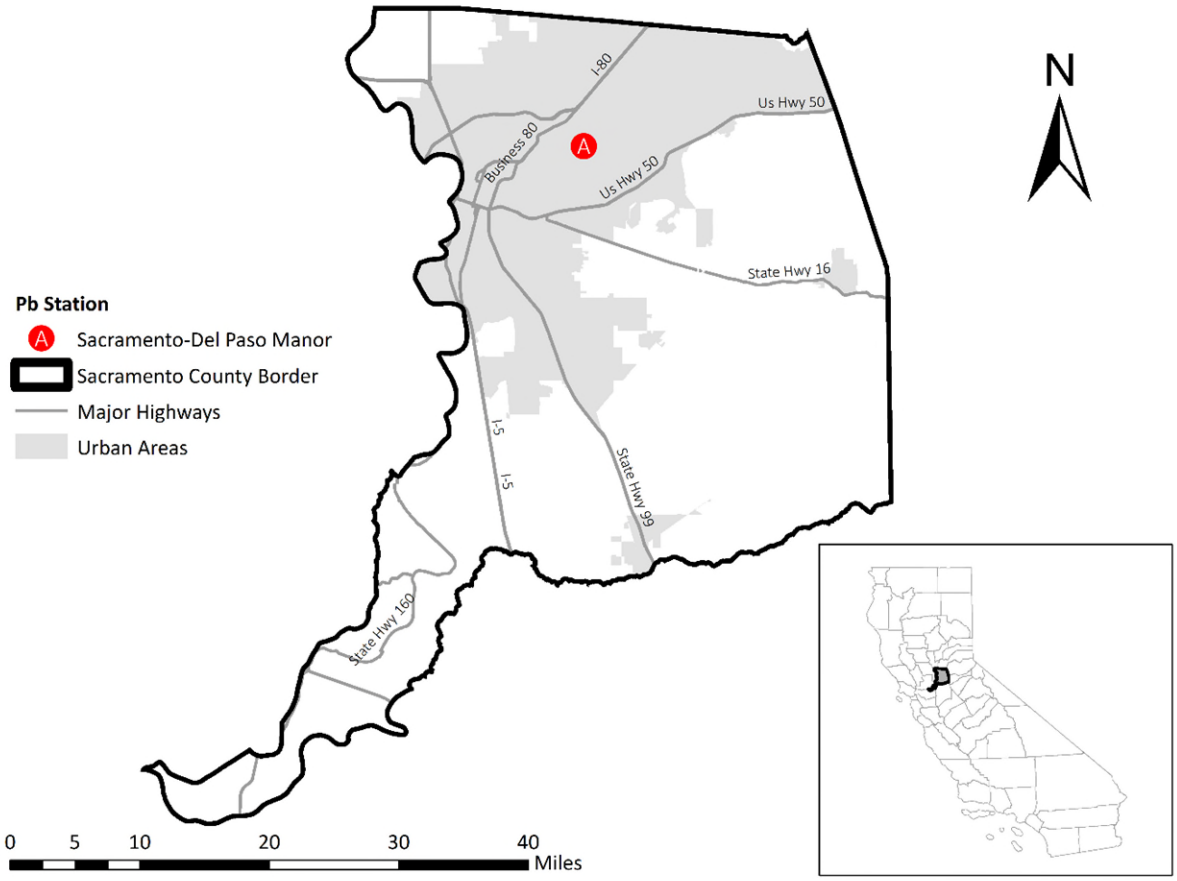


Figure 68 – Pb Network in Sacramento County.

Table 74 – Monitoring type for Pb monitors serving Sacramento County.

Site	EPA Network Affiliation*	Monitoring Type**
Sacramento-Del Paso Manor	NCORE/PAMS	Population Oriented

Note: All monitors are SLAMS (State and Local Air Monitoring Stations) monitor type unless otherwise noted.
* NCORE (National Core Multi-pollutant Monitoring Stations), PAMS (Photochemical Assessment Monitoring Station).
** These objectives are consistent with EPA monitoring types as listed in 40 CFR Part 58, Appendix D.

In 2008, EPA strengthened the NAAQS for Pb to a level of 0.15 µg m^{-3}. The design value is the maximum rolling 3-month lead-TSP average over a 3-year period not to be exceeded by any 3-month average. EPA has designated Sacramento County as unclassifiable/attainment for the 2008 federal Pb standard[77].

In Revisions to Ambient Monitoring Quality Assurance and Other Requirements promulgated on March 28, 2016 (81 FR 17248), EPA removed the Pb monitoring requirement at urban NCore sites, provided that the sampler has collected sufficient data to calculate a design value. Sacramento-Del Paso is an

[77] https://www.epa.gov/lead-designations/lead-designations-final-nonattainment-designations-rounds-1-and-2; 70 FR 72097.

NCore site, and the Pb sampler at this site had met the condition to discontinue. Thus, with EPA approval, the District discontinued the lead monitor on May 31, 2020. The Sacramento-Del Paso Manor monitor is included in this analysis as the removal was after the 2019 data year.

Pb Network Area- and Population-Served Analyses

As the only monitor representing Sacramento County, population and demographic statistics for the Sacramento-Del Paso Manor monitor represent Sacramento County as a whole. The population within Sacramento County represented by the monitor was provided courtesy of Sacramento County[78]. Area- and population-served data are presented in Table 75.

Table 75 – Area and population served by Pb monitors serving Sacramento County.

Station Name	Population Estimate (persons)*	Area (km^2)*
Sacramento-Del Paso Manor	1,555,365	2,574

* Population and area estimates based on 2020 population (source: Sacramento County[78])

Pb Data Analyses

The Pb data analysis conducted was used to determine the importance of a site based on the following methods:

- measured concentrations and exceedance probability,
- deviation from NAAQS,
- monitor-to-monitor correlation,
- trend impact, and
- removal bias.

Measured Concentration and Exceedance Probability

Monitors within the District's ambient air monitoring network were shown to have high levels of Pb, design values close to the standard, and with long historical record were considered to be of high value for characterizing pollution in an area. Table 76 presents rolling 3-month design value concentrations for 2010 through 2019 (2010-2014 data included for historical context). The exceedance probability was not calculated in the NetAssess2020 v1.1 tool and is therefore not included in this analysis.

Table 76 – Concentration analysis for Pb monitors serving Sacramento County (source: EPA AQS).

Station Name	Valid 3-Month Pb Design Value (ppb)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019**
DPM*			0.00	0.00	0.00	0.00	0.00	0.00	0.01	

DPM – Sacramento-Del Paso Manor

* Sacramento-Del Paso Manor Pb monitor came online April 2012, discontinued May 2020.

** Incomplete data year.

[78] https://www.saccounty.gov/Government/Pages/DemographicsandFacts.aspx

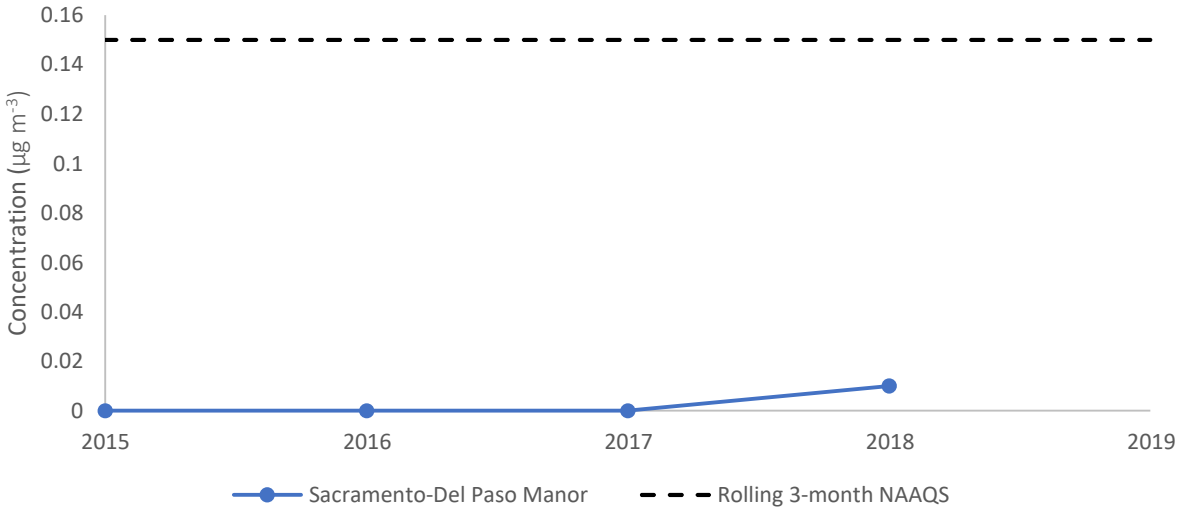


Figure 69 – 3-month Pb concentration trend (Source: EPA AQS).

Figure 69 presents the 2015 through 2019 valid design values for Pb monitors serving Sacramento County. As described in the EPA network assessment guidance (EPA, 2007), "[m]onitors that measure high concentrations or design values are ranked higher than monitors that measure low concentrations." Based on the data shown in Figure 69, the Sacramento-Del Paso Manor site sampled much lower than the 3-month standard during the assessment period. The only non-zero design value concentration in the assessment period is in 2018, which may have been impacted by wildfire smoke from the Camp Wildfire as outlined in the Ozone and $PM_{2.5}$ sections. An analysis of the event by CARB shows "smoke produced from the Camp Fire exposed Californians to dangerous levels of particulate matter and contained concerning levels of toxic metal contaminants, including lead, which spiked for about 24 hours"[79].

Deviation from NAAQS

As shown in Table 77, the deviation from NAAQS analysis shows for the 3-month standard that the Sacramento-Del Paso Manor site has a deviation value much greater than 20% of the NAAQS (0.03 ppm). This corresponds to the lowest importance based on the EPA definition that "[s]ites measuring concentrations (design values) that are very close to the NAAQS exceedance threshold are ranked highest in this analysis" (EPA, 2007). The 20% value has been used as a threshold for importance in this assessment for most other pollutants.

Table 77 – 2018 3-month Pb design value and deviation from NAAQS analysis.

Station Name	2018 Pb Design Value (ppm)*	Deviation from NAAQS (ppm)
Sacramento-Del Paso Manor	0.01	0.14

* 2019 had an incomplete design value calculation, therefore 2018 was used instead.

[79] https://ww2.arb.ca.gov/news/new-analysis-shows-spikes-metal-contaminants-including-lead-2018-camp-fire-wildfire-smoke

Pb Monitor-to-Monitor Correlation Analysis

With Sacramento-Del Paso Manor being the only Pb monitor characterizing Pb concentrations in Sacramento County, monitor-to-monitor correlation was not evaluated.

Trend Analysis

Monitors that have a long historical record are valuable for tracking trends. In this analysis, site importance is based on the duration of the continuous measurement record. Table 78 shows the year that Pb measurements began at the Sacramento-Del Paso Manor station. This site has a short trend when compared to other pollutants in the network, and as mentioned previously has been discontinued. Therefore, no recommendation is available for this analysis.

Table 78 – Date of operation for the Pb station serving Sacramento County.

Station Name	Begin Year of Pb Operation
Sacramento-Del Paso Manor	2012

Pb Monitor Removal Bias Analysis

With Sacramento-Del Paso manor being the only monitor within the District network, removal bias was not evaluated.

Pb Minimum Number of Monitors Required

The minimum number of monitors required under Appendix D of 40 CFR Part 58 and number of sites in the Sacramento Metropolitan Statistical Area (MSA) are listed in Table 79. Federal regulations require a Pb monitor at NCore sites in CBSAs with more than 500,000 people. In Revisions to Ambient Monitoring Quality Assurance and Other Requirements promulgated on March 28, 2016 (81 FR 17248), EPA removed the Pb monitoring requirement at urban NCore sites, provided that the sampler has collected sufficient data to calculate a design value. Sacramento-Del Paso is an NCore site, and the Pb sampler at this site had met the condition to discontinue. Thus, with EPA approval, the District discontinued the Pb monitor on May 31, 2020. The Sacramento-Del Paso Manor monitor is included in this analysis as the removal was after the 2019 data year. Source-oriented monitors are also required for non-airport sources, which emit more than 0.5 tons per year or airports, which emit more than 1.0 ton per year. There are no emission sources greater than 0.5 tons per year in Sacramento County.

Table 79 – Minimum monitoring requirements within Sacramento MSA.

Type	Sites Required	Sites in Sacramento MSA	Additional Sites Needed
NCore	0	1**	0
Source Oriented*	0	0	0

* No non-airport source greater than 0.5 tons per year or airport source greater than 1.0 tons per year; 2017 National Emission Inventory (updated April 2020).
** The Sacramento-Del Paso Manor monitor has been discontinued as of May 31 2020.

Conclusions

The Sacramento-Del Paso Manor site is the single site in Sacramento County to sample Pb. In Revisions to Ambient Monitoring Quality Assurance and Other Requirements promulgated on March 28, 2016 (81 FR 17248), EPA removed the Pb monitoring requirement at urban NCore sites, provided that the sampler has collected enough data to calculate a design value. Pursuant to this revision, EPA Region 9 approved the discontinuation of the Sacramento-Del Paso Manor Pb monitor on April 20, 2020. Low monitored concentrations and a lack of non-exceptional emission sources triggering source-oriented monitoring requirements suggest no additional monitors are required to be added to the network.

Sulfur Dioxide (SO_2) Network Analysis

Monitoring Objectives

Sulfur dioxide (SO_2) is a component of sulfur oxides and is emitted into the atmosphere largely through the burning of fossil fuels by power plants and other industrial facilities. Smaller sources of SO_2 include industrial processes, natural sources such as volcanoes, and locomotives, ships and other vehicles and heavy equipment that burn fuel with high sulfur content.

Sacramento County has one (1) SLAMS SO_2 monitoring station, Sacramento-Del Paso Manor, as shown in Figure 70. Based on the characteristics of this site, it is designated as population oriented (see Table 80). Rankings are not included in this analysis as there is only a single SO_2 monitoring site.

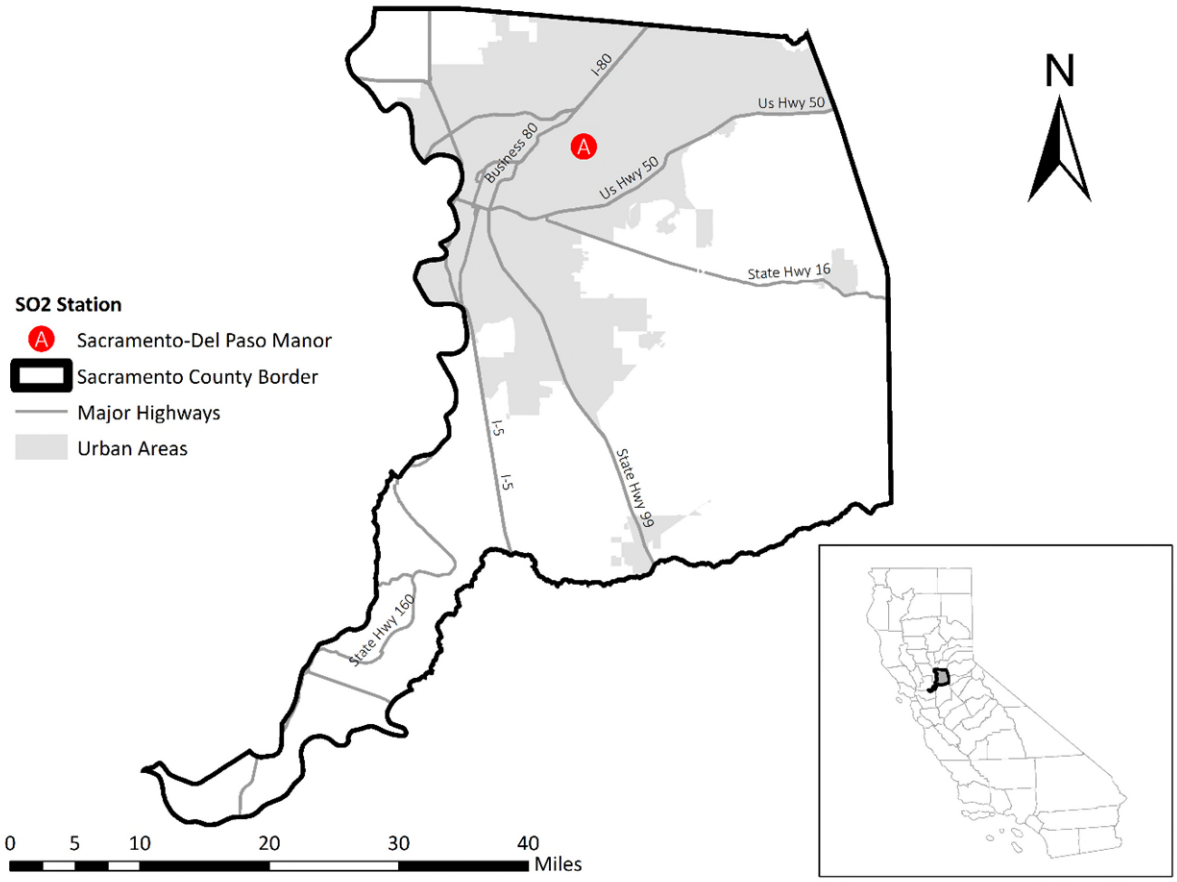


Figure 70 – SO_2 Network in Sacramento County.

Table 80 – Monitoring objective for SO_2 monitors serving Sacramento County.

Site	EPA Network Affiliation*	Monitoring Type**
Sacramento-Del Paso Manor	NCORE/PAMS	Population Oriented

Note: All monitors are SLAMS (State and Local Air Monitoring Stations) monitor type unless otherwise noted.
* NCORE (National Core Multi-pollutant Monitoring Stations), PAMS (Photochemical Assessment Monitoring Station).
** Consistent with EPA monitoring types as listed in 40 CFR Part 58, Appendix D.

In 2010, EPA revised the SO_2 NAAQS by establishing a 1-hour standard at a level of 75 parts per billion (ppb). The design value is the 99th percentile of the annual distribution of daily maximum 1-hour averages, averaged over three years. EPA has designated Sacramento County as attainment for the federal SO_2 standard[80].

SO_2 Network Area- and Population-Served Analyses

As the only monitor representing Sacramento County, population and demographic statistics for the Sacramento-Del Paso Manor monitor represent Sacramento County as a whole. The population within Sacramento County represented by the monitor was provided courtesy of Sacramento County[78]. Area- and population-served data are presented in Table 81.

Table 81 – Area and population served by SO_2 monitors serving Sacramento County.

Station Name	Population Estimate (persons)*	Area (km^2)*
Sacramento-Del Paso Manor	1,555,365	2,574

* Population and area estimates based on 2020 population (source: Sacramento County[81])

SO_2 Data Analyses

The SO_2 data analysis conducted was used to determine the importance of a site based on the following methods:

- measured concentrations and exceedance probability,
- deviation from NAAQS,
- monitor-to-monitor correlation,
- trend impact, and
- removal bias.

Measured Concentration and Exceedance Probability

Monitors within the District's ambient air monitoring network shown to have high levels of SO_2, design values close to the standard, and with long historical record were considered to be of high value for characterizing pollution in an area. Table 82 presents 1-hour design value concentrations for 2010

[80] https://www.epa.gov/sulfur-dioxide-designations
[81] https://www.saccounty.gov/Government/Pages/DemographicsandFacts.aspx

through 2019. The exceedance probability was not calculated in the NetAssess2020 v1.1 tool and is therefore not included in this analysis.

Table 82 – Concentration analysis for SO_2 monitors serving Sacramento County (source: EPA AQS).

Station Name	Valid 1-hour SO_2 Design Value (ppb)									
	2010	2011	2012	2013	2014	2015	2016	2017*	2018	2019
DPM		2	2	2	3	5	7			

DPM – Sacramento-Del Paso Manor
* The 2017 annual value did not meet completeness criteria, therefore 2017, 2018, and 2019 design values are invalid.

Figure 71 presents the 2010 through 2019 valid design values for SO_2 monitors serving Sacramento County. As described in the EPA network assessment guidance (EPA, 2007), "[m]onitors that measure high concentrations or design values are ranked higher than monitors that measure low concentrations." Based on the data shown in Figure 71, the Sacramento-Del Paso Manor site sampled much lower than the 1-hour standard for valid design values during the assessment period of 2015-2019.

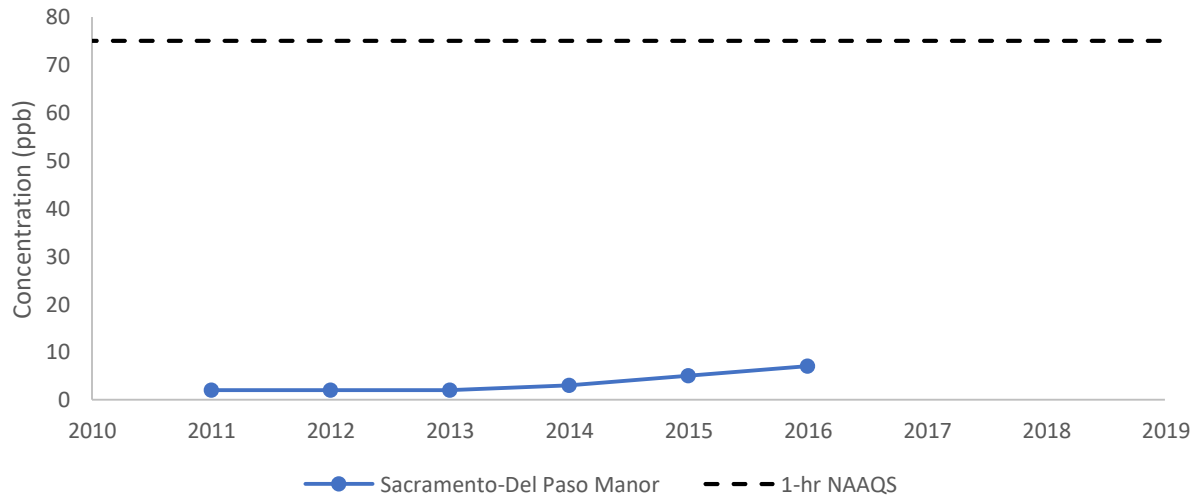


Figure 71 – 1-hour SO_2 concentration trend (Source: EPA AQS).

Deviation from NAAQS

As shown in Table 83, the deviation from NAAQS analysis shows for the 1-hour standard that the Sacramento-Del Paso Manor site has deviation values much greater than 20% of the NAAQS (15 ppb). This corresponds to the lowest importance based on the EPA definition that "[s]ites measuring concentrations (design values) that are very close to the NAAQS exceedance threshold are ranked highest in this analysis" (EPA, 2007). The 20% value has been used as a threshold for importance in this assessment for most other pollutants.

Table 83 – 2016 1-hour SO_2 design value and deviation from NAAQS analysis.

Station Name	2016 SO_2 Design Value (ppb)*	Deviation from NAAQS (ppb)
Sacramento-Del Paso Manor	7	68

* 2019 had an incomplete design value calculation, therefore the last valid year was used instead (2016).

SO_2 Monitor-to-Monitor Correlation Analysis

With Sacramento-Del Paso Manor being the only SO_2 monitor characterizing SO_2 concentrations in Sacramento County, monitor-to-monitor correlation was not evaluated.

Trend Analysis

Monitors that have a long historical record are valuable for tracking trends. In this analysis, site importance is based on the duration of the continuous measurement record. Table 84 shows the year that SO_2 measurements began at the Sacramento-Del Paso Manor station. This site has a long historical sampling trend of over 40 years. However, as it is the only site in Sacramento County, no recommendation is available for this analysis.

Table 84 – Date of operation for the SO_2 station serving Sacramento County.

Station Name	Begin Year of SO_2 Operation
Sacramento-Del Paso Manor	1980

SO_2 Monitor Removal Bias Analysis

With Sacramento-Del Paso manor being the only monitor within the District network, removal bias was not evaluated.

SO_2 Minimum Number of Monitors Required

The minimum number of monitors required under Appendix D of 40 CFR Part 58 and number of sites in the Sacramento MSA are listed in Table 85. SO_2 monitoring requirements are determined based on a combination of population and emissions. The Population Weighted Emissions Index (PWEI) is calculated by multiplying the population of each CBSA by the total amount of SO_2 (in tons per year) emitted within the CBSA area, then dividing the resulting product by one million. CBSAs with a calculated PWEI (in million persons-ton per year) greater than 1,000,000 require three (3) SO_2 monitoring sites. A PWEI between 100,000 and 1,000,000 requires a minimum of two (2) SO_2 monitoring sites, and CBSAs with a PWEI between 5,000 and 100,000 require a minimum of one (1) SO_2 monitoring site. Based on data from the 2017 National Emissions Inventory (NEI; updated April 2020)[82] of 940 tons of SO_2 emissions[83]and an estimated population of the Sacramento MSA of 2.3 million persons, the PWEI for the Sacramento MSA is calculated to be 2,162 million persons-tons per year. However, per 40 CFR Part 58 3(b), NCore sites are required to monitor SO_2. Therefore, the District operates one SO_2 monitor at the Sacramento-Del Paso Manor site to satisfy NCore requirements.

[82] https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data

Table 85 – Minimum monitoring requirements within Sacramento MSA.

Sites Required	Sites in Sacramento MSA	Additional Sites Needed
1	1*	0

* Required as part of NCore monitoring station. Total SO_2: 940 tons (2017 National Emission Inventory, updated April 2020); Population Weighted Emission Index: 2,162 million persons-tons per year (Per 40 CFR Part 58, Appendix D, $PWEI = \frac{Total\ SO_2 \times MSA\ Population}{1{,}000{,}000}$).

Conclusions

The Sacramento-Del Paso Manor site is the single site in Sacramento County to sample SO_2. EPA has designated Sacramento County as attainment for the federal SO_2 standard as calculated design values at this site are well below the 1-hour NAAQS. Low monitored concentrations and calculated population weighted emissions index in accordance with 40 CFR Part 58 Appendix D suggest no additional monitors are required to be added to the network. In summary, the current SO_2 monitoring network meets all federal requirements and supports District monitoring objectives.

Meteorological Network Analysis

Monitoring Objectives

Surface meteorological measurements are currently being collected at six (6) monitoring sites within the District's network as seen in Figure 72. National Oceanic and Atmospheric Administration (NOAA) Surface weather observation stations[84] within Sacramento County are also included in Figure 72. Table 86 presents the meteorological parameters currently being measured at each District monitoring site.

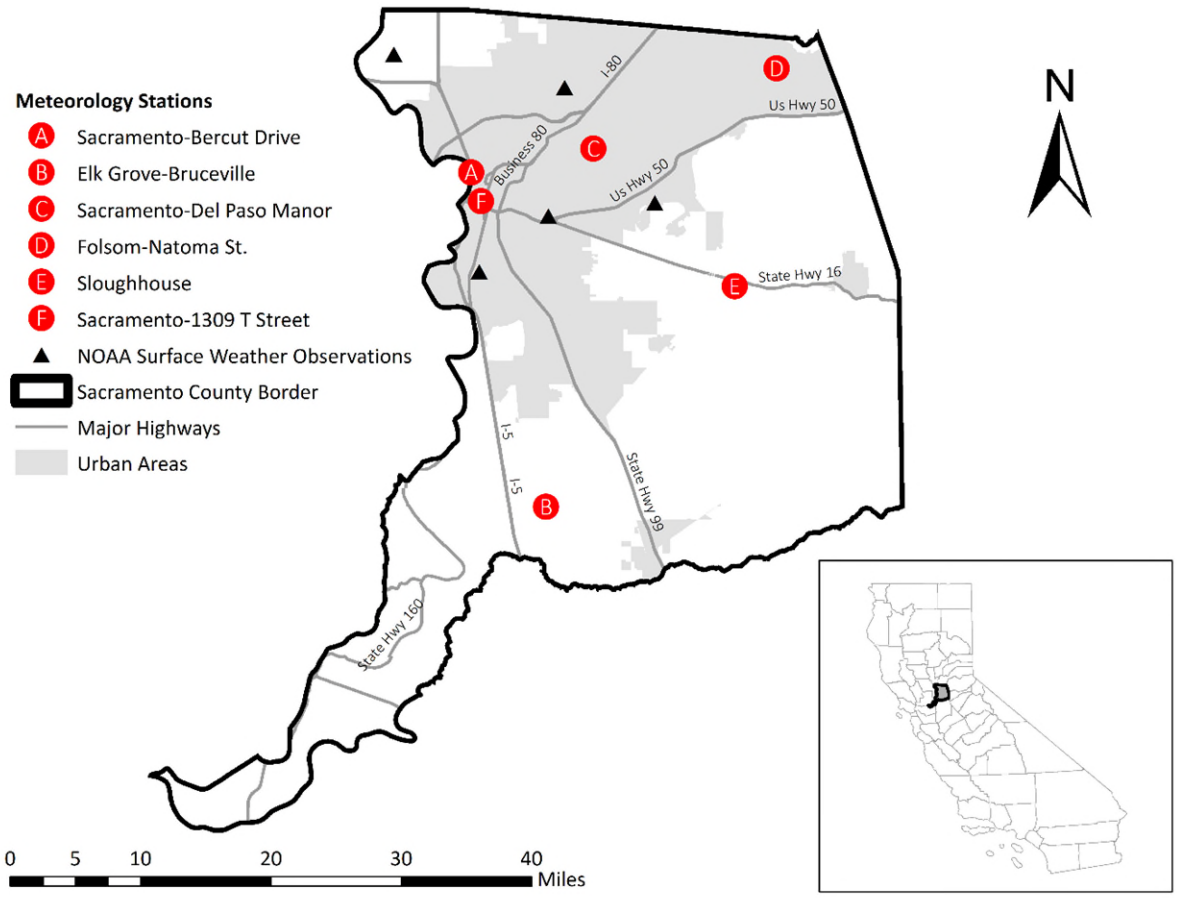


Figure 72 – Meteorological Network in Sacramento County and National Oceanic and Atmospheric Administration (NOAA) surface weather observations (source: NOAA)

[84] NOAA National Centers for Environmental Information (2001): Integrated Global Surface Hourly Dataset. NOAA National Centers for Environmental Information. https://data.noaa.gov/onestop/collections/details/da357c46-5107-417f-bc50-3130599a836d?f=dataFormats:ARCGIS

Table 86 – Meteorological parameters measured by station in Sacramento County.

	Outdoor Temperature	Relative Humidity	Solar Radiation	Ultraviolet Radiation	Barometric Pressure	Precipitation	Wind Direction & Speed	Ceilometer
Sacramento-Bercut Dr.	✓						✓	
Elk Grove-Bruceville	✓	✓	✓	✓	✓	✓	✓	✓
Sacramento-Del Paso Manor	✓	✓	✓				✓	
Folsom-Natoma St.	✓	✓	✓				✓	
Sloughhouse							✓	
Sacramento-1309 T Street	✓	✓					✓	

The District meteorological network satisfies all federal requirements as outlined in 40 CFR Appendix D to Part 58. There are specific requirements for monitoring programs, these are outlined in Table 87.

Table 87 – Meteorological requirements in 40 CFR Part 58.

Parameter	NCore	PAMS*	Near Road**
Wind Direction	✓	✓	✓
Wind Speed	✓	✓	✓
Relative Humidity	✓	✓	
Ambient Temperature	✓	✓	
Atmospheric Pressure		✓	
Hourly Precipitation		✓	
Hourly Averaged Mixing Height		✓	
Hourly Averaged Solar Radiation		✓	
Hourly Averaged Ultraviolet Radiation		✓	

✓ Installed
Not Required
Recommended

* See the PAMS section for more information.
**Meteorological parameters are not required, but are recommended[85].

The District air monitoring network is designed to meet three basic monitoring objectives as required by 40 CFR Appendix D to Part 58:

1. provide air pollution data to the general public in a timely manner;
2. support compliance with ambient quality standards and emissions strategy development; and
3. support air pollution research studies.

[85] As per the EPA Near-road NO_2 Monitoring Technical Assistance Document, "Although meteorological measurements were originally proposed in the [Notice of Proposed Rulemaking] for NO_2 to be required at near-road NO_2 monitoring sites, the EPA did not ultimately require them within 40 CFR Part 58. However, the EPA strongly encourages states to measure meteorological parameters at near-road sites whenever possible."; https://www.epa.gov/sites/default/files/2020-09/documents/nearroadtad.pdf.

The meteorological network supports meeting these objectives in multiple ways. Some examples of this are as follows. Surface wind speed and direction are integral in determining ground-level pollution transport throughout the county, especially important for public notification. These measurements are vital in accurately forecasting $PM_{2.5}$ conditions in the wintertime as part of the Check Before You Burn program as well as forecasting for possible high wind and dust events (PM_{10}). Relative humidity, solar radiation, and ultraviolet radiation help to understand chemical processes within the atmosphere in the particle, gas, and aerosol phases. These measurements are all used as part of the Spare the Air summertime O_3 forecasting. Upper atmosphere information from the ceilometer provides valuable data to forecast wintertime particulate matter concentrations, aid in model assimilation and verification, identify pollution plumes which may be elevated above the surface (e.g. wildfire smoke for Exceptional Event demonstrations), and to help characterize dispersion, fumigation and source contribution of pollutants. Where available, the District provides meteorological data in real time for public information, which is displayed on the National Weather Service (NWS) Weather & Hazards Data Viewer[86]. This data combined with NOAA NWS stations, which also provide real time meteorological data as seen in Figure 72, provide an accurate representation of meteorological measurements within Sacramento County.

The District meteorological network adequately satisfies all federal requirements as well as District objectives. There are no sites in Sacramento County recommended for removal.

[86] https://www.wrh.noaa.gov/map/

Photochemical Assessment Monitoring Station (PAMS) Network Analysis

Monitoring Objectives

The PAMS network was started in the early 1990s as an ozone precursor monitoring network to meet the requirements of Section 182(c)(1) of the Clean Air Act (CAA). As part of the 2015 Ozone National Ambient Air Quality Standard review[87], significant changes were made to the PAMS requirements[88] including calling for ozone precursor measurements to be made at existing NCore sites in Core Based Statistical Areas of over 1 million population. Sacramento County qualifies for this requirement, and therefore, the NCore Sacramento-Del Paso Manor site is determined to be the primary PAMS monitoring station.

Ground-level ozone photochemically forms in the atmosphere through chemical reactions in the presence of precursor pollutants and sunlight. Time is required for the reactions to occur and while ozone is being chemically formed, air masses are generally transported out of the area where precursor pollutants were emitted. In Sacramento County, prevailing ozone season winds transport ozone precursors to higher elevations in the easternmost portion of the county (topography is included in Figure 73). As seen in Figure 73, there are three (3) ambient air monitoring sites (Sacramento-Del Paso Manor, Elk Grove-Bruceville, and Folsom-Natoma), which are part of the legacy PAMS monitoring network within Sacramento County to sample PAMS species. Since the start of PAMS monitoring in Sacramento County, the District has designated Elk Grove-Bruceville, Sacramento-Del Paso Manor, and Folsom-Natoma St. as type I, II, and III PAMS sites respectively. The types of PAMS sites are as follows:

1. Type I – upwind sites
2. Type II – maximum ozone precursor sites
3. Type III – maximum ozone concentrations sites
4. Type IV – downwind sites

[87] https://www.epa.gov/ground-level-ozone-pollution/2015-revision-2008-ozone-national-ambient-air-quality-standards-naaqs
[88] https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&mc=true&r=PART&n=pt40.6.58#ap40.6.58.0000_0nbspnbspnbsp.d

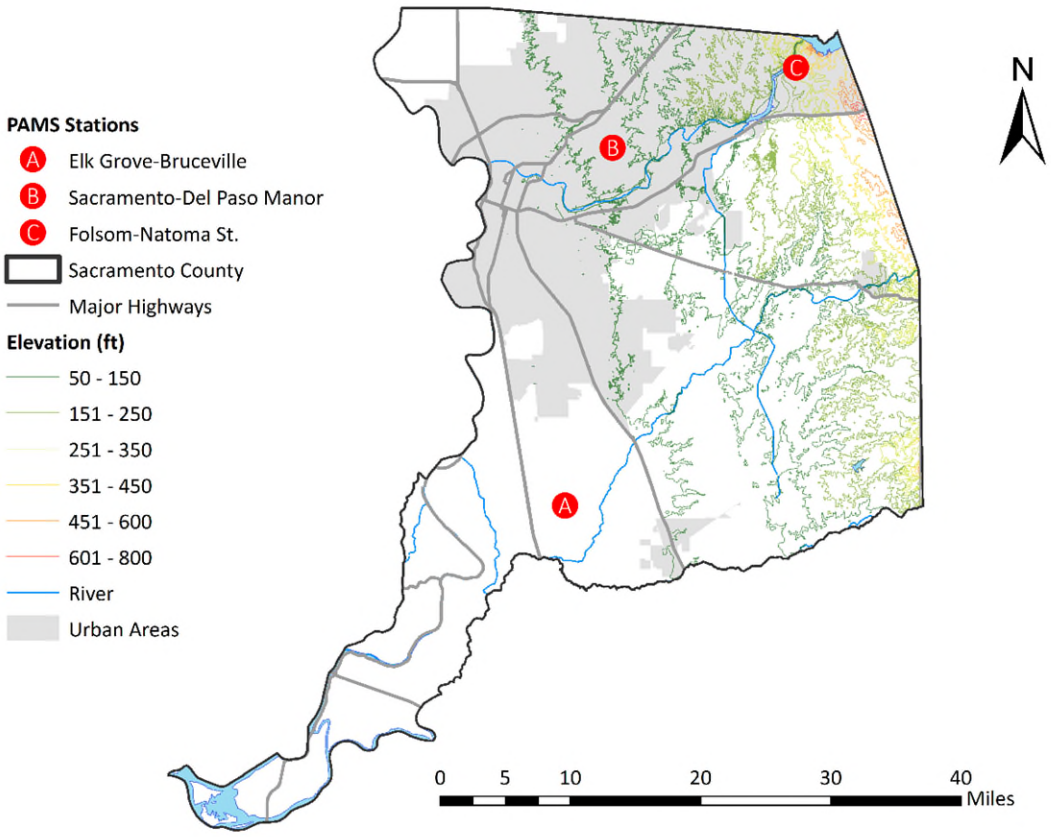


Figure 73 – PAMS Network and terrain in Sacramento County.

PAMS Minimum Monitoring Requirements

According to 40 CFR Part 58 Appendix D, Section 5, state and local monitoring agencies are required to collect and report PAMS measurements at each NCore site in a CBSA with a population of 1,000,000 or more. The 2015 review of National Ambient Air Quality Standards for Ozone (80 FR 65292) required the State to develop an Enhanced Monitoring Plan (EMP) for enhanced ozone monitoring activities. The District, CARB, and neighboring air districts worked together to determine the appropriate monitoring plan. CARB is responsible for submitting the EMP for the entire state, including all Primary Quality Assurance Organizations (PQAO) and all air districts within the CARB PQAO that submit their own annual network plans and/or 5-year monitoring network assessments. Details on the Sacramento nonattainment area EMP are provided in the EMP portion of the 2020 Monitoring Network Assessment developed by CARB[89].

[89] Document referenced in CARB Annual Network Plan here: https://ww2.arb.ca.gov/our-work/programs/ambient-air-monitoring-regulatory/annual-monitoring-network-report

Other requirements of the revised PAMS network are the deployment and operation of a continuous hourly-averaged speciated volatile organic compound (VOC) sampler[90], specifically an automated gas chromatograph (autoGC) system, and a ceilometer to measure the mixing layer height.

In 2006, EPA eliminated the requirement to measure speciated carbonyls at PAMS sites with the exception of sites in areas designated as severe or extreme non-attainment for the 8-hour ozone standard. EPA has since begun revision of Compendium Method TO-11A for measuring carbonyl concentrations based on work performed to optimize and modernize the method.

Currently, as the transition to the revised PAMS requirements is in progress, the District has three (3) active PAMS monitoring sites (DPM, BRU, FOL) that meet the previous PAMS monitoring requirements and one site (DPM; NCore site) that is scheduled to meet current PAMS requirements as outlined in 40 CFR Part 58, Appendix D following station renovations (see PAMS section for more details).

In summary, in accordance with 40 CFR Appendix D to Part 58 each required PAMS site is expected to measure:

- Hourly averaged speciated volatile organic compounds (VOCs),
- Three 8-hour averaged carbonyl samples per day on a 1 in 3 day schedule, or hourly averaged formaldehyde,
- Hourly averaged O_3,
- Hourly averaged nitrogen oxide (NO), true nitrogen dioxide (NO_2), and total reactive nitrogen (NOy),
- Hourly averaged ambient temperature,
- Hourly vector-averaged wind direction,
- Hourly vector-averaged wind speed,
- Hourly average atmospheric pressure,
- Hourly averaged relative humidity,
- Hourly precipitation,
- Hourly averaged mixing-height,
- Hourly averaged solar radiation, and
- Hourly averaged ultraviolet radiation.

[90] EPA PAMS VOC target list can be found here: https://www.epa.gov/amtic/photochemical-assessment-monitoring-stations-pams-volatile-organic-compound-target-list.

PAMS Monitoring and Revisions

In alignment with the revised PAMS requirements, the Sacramento-Del Paso Manor site will be the core PAMS station and the Elk Grove-Bruceville Rd. and Folsom-Natoma St. sites will both serve as enhanced ozone monitoring sites. The following modifications to the District PAMS network are currently planned to meet these requirements:

- To offset the added demands at the NCore site and save staff time and resources, the District will request approval from EPA to discontinue the following PAMS parameters that are identified in CARB's Enhanced Monitoring Plan:
    1. speciated volatile organic compounds (VOCs) at Elk Grove-Bruceville Rd.
    2. speciated VOCs at Folsom-Natoma St.
    3. reactive oxides of nitrogen (NOx) at Folsom-Natoma St.
- To accommodate the autoGC and accompanying support equipment, the District will be rebuilding the PAMS station at the Sacramento-Del Paso Manor site. Construction work is scheduled to be completed prior to the 2022 PAMS season, however, completion may be delayed due to the global pandemic and supply chain issues.
- The District will be submitting a waiver to operate some of the required meteorological instruments (ultraviolet radiation, precipitation, and barometric pressure) at Elk-Bruceville Rd. instead of Sacramento-Del Paso Manor.

Adjacent to the Elk Grove-Bruceville site are the Franklin Field radar wind profiler (RWP) and radio acoustic sounding system (RASS). These instruments measure wind and temperature in the upper meteorological levels and are operated year-round. They have historically been included as required upper air measurements in the PAMS network. However, the RWP and RASS instruments malfunctioned in October 2016. Pursuant to the 2015 revisions to the PAMS requirements for upper air measurements, the District installed and began operation of a ceilometer at Elk Grove-Bruceville in January 2018 after receiving EPA approval of a waiver to allow measurements to be made at an alternative location than the NCore site.

Table 88 lists the parameters that the District plans to operate at each of the PAMS and enhanced monitoring sites in Sacramento County.

Table 88 – Enhanced PAMS monitoring parameters planned for each station.

Site Name	O_3	NO_2	autoGC	Carbonyl	NMHC*	Meteorology**	Ceilometer
Elk Grove-Bruceville Rd.	✓	✓			✓	✓	✓
Sacramento-Del Paso Manor	✓	✓	✓	✓		✓	
Folsom-Natoma St.	✓	✓			✓	✓	

* Non-methane hydrocarbon, a precursor for O_3; the NMHC analyzers are on a temporary shutdown due to instrument malfunction and are being replaced

** Surface meteorology at Elk Grove-Bruceville includes: temperature, relative humidity, wind direction and speed, solar radiation, ultraviolet radiation, precipitation, and barometric pressure. Surface meteorology at Sacramento-Del Paso Manor and Folsom-Natoma St. include: temperature, relative humidity, wind direction and speed, and solar radiation

In accordance with PAMS requirements, the District will continue to sample speciated carbonyl compounds[91] on the required schedule.

PAMS Conclusions and Recommendations

As seen in the ozone section of this assessment, ozone concentrations continue to improve in Sacramento County. This is due in part to the implementation of District and State programs designed to reduce local and statewide ozone precursor emissions and ultimately ozone formation. Also, the PAMS monitoring network meets all federal requirements and supports District monitoring objectives. Therefore, as also outlined in the CARB EMP, no additional ozone or ozone precursor monitoring as part of the PAMS network is recommended for Sacramento County.

[91] PAMS compound lists are updated in a 2017 EPA memorandum: https://www.epa.gov/sites/default/files/2019-11/documents/targetlist_0.pdf

Additional Enhanced Air Monitoring Efforts and Outreach

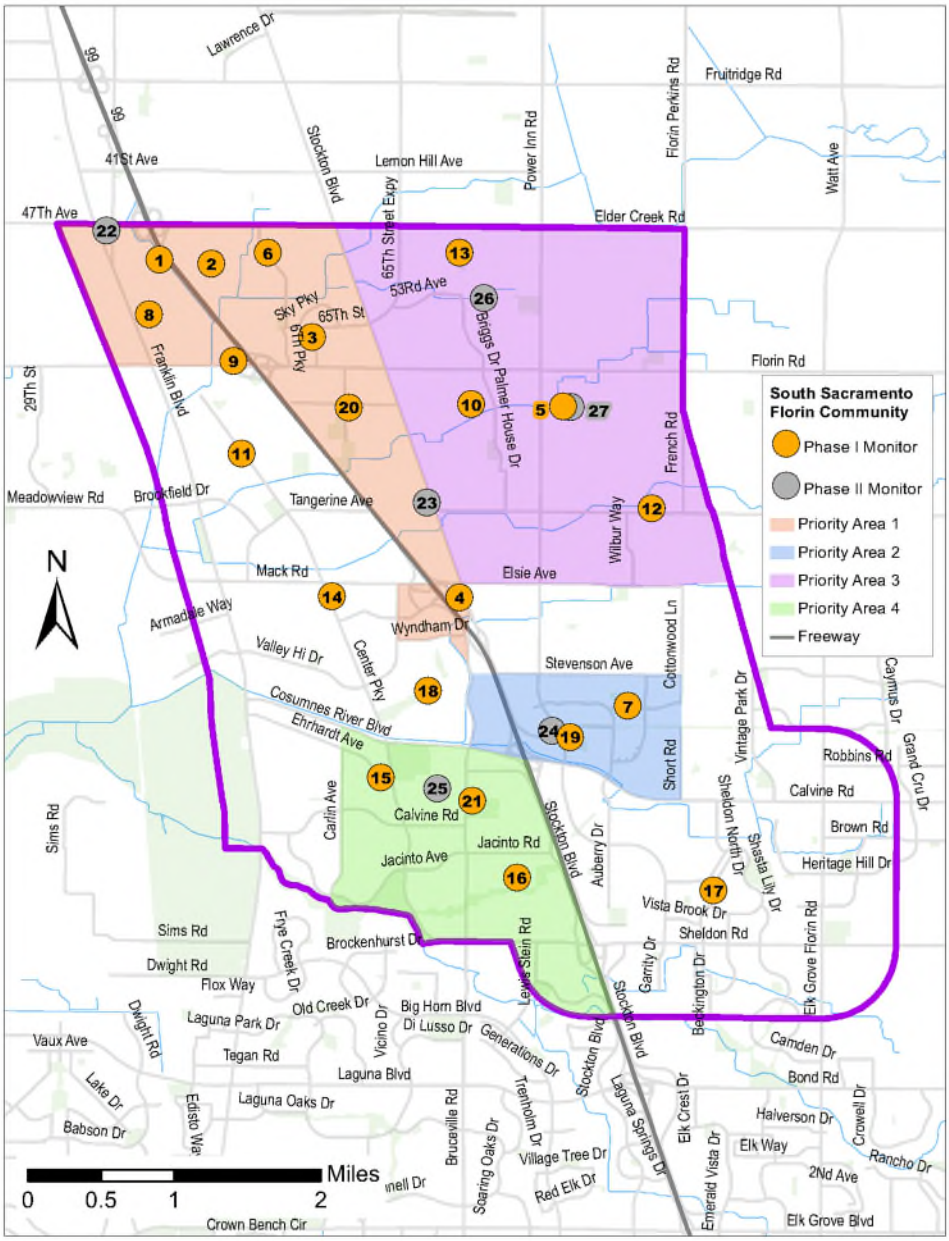
The District is committed to effectively reducing exposure to air pollution and protecting public health. As a direct result of these commitments, when funding has been available, the District has initiated and continue to implement additional monitoring efforts beyond requirements. It is recognized that these efforts not only enhance our understanding of our air pollution in our region, but also at the community level. The following examples also highlight the importance that partnerships play with sister agencies, businesses, community members, and non-profit organizations to bring resources, experiences and solutions to improve air quality for our communities.

While these monitoring efforts are not required, these monitoring efforts can provide valuable information, which can be used to support monitoring objectives of providing timely information to the public, development of emission reduction strategies, and support air pollution research studies. Some examples of these include but are not limited to those listed below.

Community Air Quality Monitoring Programs and/or Projects

Community Air Protection program (AB 617) in the South Sacramento/Florin community.

In 2017, Governor Brown signed Assembly Bill 617 (AB 617; C. Garcia, Chapter 136, Statutes of 2017) to develop a new community-focused program to more effectively reduce exposure to air pollution and preserve public health. This bill directs the CARB and local air districts to take measures to protect communities disproportionally impacted by air pollution. On September 27, 2018, CARB selected 10 communities across the state to be the first communities to develop and implement a community emission reduction plan and/or an air monitoring plan. The District is committed to protecting all residents of Sacramento County, especially those disproportionally impacted by air pollution. Therefore, the District recommended several communities to CARB in Sacramento County for funding, and the South Sacramento/Florin community was selected for the program in the inaugural year. In collaboration with community members, the District deployed various monitors within the South Sacramento/Florin community, as shown in Figure 74, and these monitors are part of a three-phased approach. Phase 1 deployed sensors to provide real time monitoring of $PM_{2.5}$ concentrations. Phase 2 deployed more advanced monitoring equipment to collect detailed air quality information and determine in which area the mobile laboratory (Phase 3) is anticipated to be installed by fall/winter of 2022. The Phase 2 sites measure black carbon, toxic metals, and volatile organic compounds (VOCs). Phase 3 will be the deployment of a mobile laboratory that will use professional-grade air monitoring equipment to collect data to determine what type of air pollution sources are impacting the community. This air monitoring data will help understand and characterize the localized air pollution and the information may be used to develop strategies to reduce or mitigate air pollution and exposure in the community. In addition, the data from Phase 1 can provide timely local $PM_{2.5}$ information to help inform the community about its air quality. For more information on the air monitoring, pollutants being measured, and access to the data, see the Community Air Protection page on the District website at http://www.airquality.org/Air-Quality-Health/Community-Air-Protection.



1	Bowling Green Park	11	Parkway Swim Club	21	Valley Hi-North Laguna Library
2	Nicholas Park	12	Elk Grove Adult and Community Education	22	SFD Station #56
3	Sacramento County Sheriff Service Center	13	Camellia Elementary School	23	Veterans of Foreign Wars Post 1267
4	Mack Road Partnership	14	Mack Road Valley Hi Community Center	24	Impact Community Church
5	Florin Elementary School	15	Valley High School	25	Consumnes River College
6	Nicholas Elementary School	16	Irene B West Elementary School	26	Sump 50
7	Isabelle Jackson Elementary School	17	Raymond Case Elementary School	27	Florin Elementary School
8	Bowling Green Elementary School	18	Herman Leimbach Elementary School		
9	District Council 16 Tapers and Glazers Union Hall	19	Countryside Community Park		
10	David Reese Elementary School	20	Southgate Library		

Figure 74 – Monitor locations in the South Sacramento/Florin AB617 community. For more information, visit the District website at http://www.airquality.org/Air-Quality-Health/Community-Air-Protection.

Quantification of Local-Scale Benzene and other Mobile Source Air Toxics in Sacramento Environmental Justice Communities

In late 2020, the EPA awarded a grant to the District to study toxic pollutants from mobile sources in two underserved communities in Sacramento County. The results from this study will provide a better understanding of toxic pollutants and the health risk from mobile toxic emissions in the (AB617) South Sacramento-Florin Community and a North Sacramento community.

In this project, the District is extending measurements of air toxics and black carbon (BC) at the six Phase II community sites in South Sacramento (Figure 74) by six months, to complete a year of monitoring. Existing measurements will be expanded with high time resolution benzene, toluene, and xylenes (BTX) measurements at three of the six community sites in South Sacramento. Additionally, high time resolution measurements of BTX, BC, particulate matter, nitrogen dioxide, and meteorology will be installed at a site in one other Sacramento environmental justice community for a year. The results from these air monitoring efforts will be synthesized with South Sacramento- Florin community-level emission inventory development and community outreach. The collected data will be used to:

1. compare pollutant concentrations among sites to identify areas of high concentrations;
2. assess the impact of mobile source versus other emissions by analyzing BTX and BC data;
3. compare concentrations with relative emissions in emission inventories and CalEnviroScreen and/or EJScreen predictions of air toxics;
4. conduct wind direction analyses to assess the direction of potential sources; and
5. supplement and leverage other District monitoring in the community to gain a full picture of air toxics and criteria pollutant exposure in and among Sacramento communities.

Wildfire Smoke Air Pollution Emergency Plan (AB 661)

As part of the District's commitment to protecting the residents of Sacramento County, the District under Assembly Bill 661[92] Wildfire Smoke Air Pollution Emergency Plan: Sacramento Metropolitan Air Quality Management District (McCarty, Chapter 392, Statutes of 2019). A Wildfire Air Quality Emergency Plan is currently being developed by the District in coordination with the Sacramento County health officer and in consultation with the following[92]:

- Local offices of emergency management or emergency services.
- School districts.
- Regional planning agencies.
- The state board.

The District has or is developing tools, outreach materials, and an improved communication plan to be utilized in the case of a wildfire event and has made or will make these available on the District website[93]. These materials include actions for schools, businesses, and public agencies to take to mitigate the impact of wildfire smoke.

[92] California Legislative Information.
https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB661
[93] http://www.airquality.org/Air-Quality-Health/Climate-Change/Public-Outreach/Wildfire-Smoke-Information.

Sacramento Neighborhoods Activating on Air Quality project

The District has worked with a group of local non-profit organizations – Valley Vision, WALKSacramento, Breathe CA Sacramento Region, and Green Tech Education – to help the North Sacramento/Norwood and Oak Park neighborhoods monitor their air, understand how air quality impacts health, and develop a plan to reduce exposure to air pollution[94]. Valley Vision describes the project as involving "…four primary components: 1) air monitoring outreach and siting; 2) education; 3) community workshops; and 4) coalition building."[94] A map of the study areas is shown in Figure 75. This project will help promote air quality awareness in these communities disproportionally impacted by air pollution and provide particulate matter data in these communities currently without District monitors.

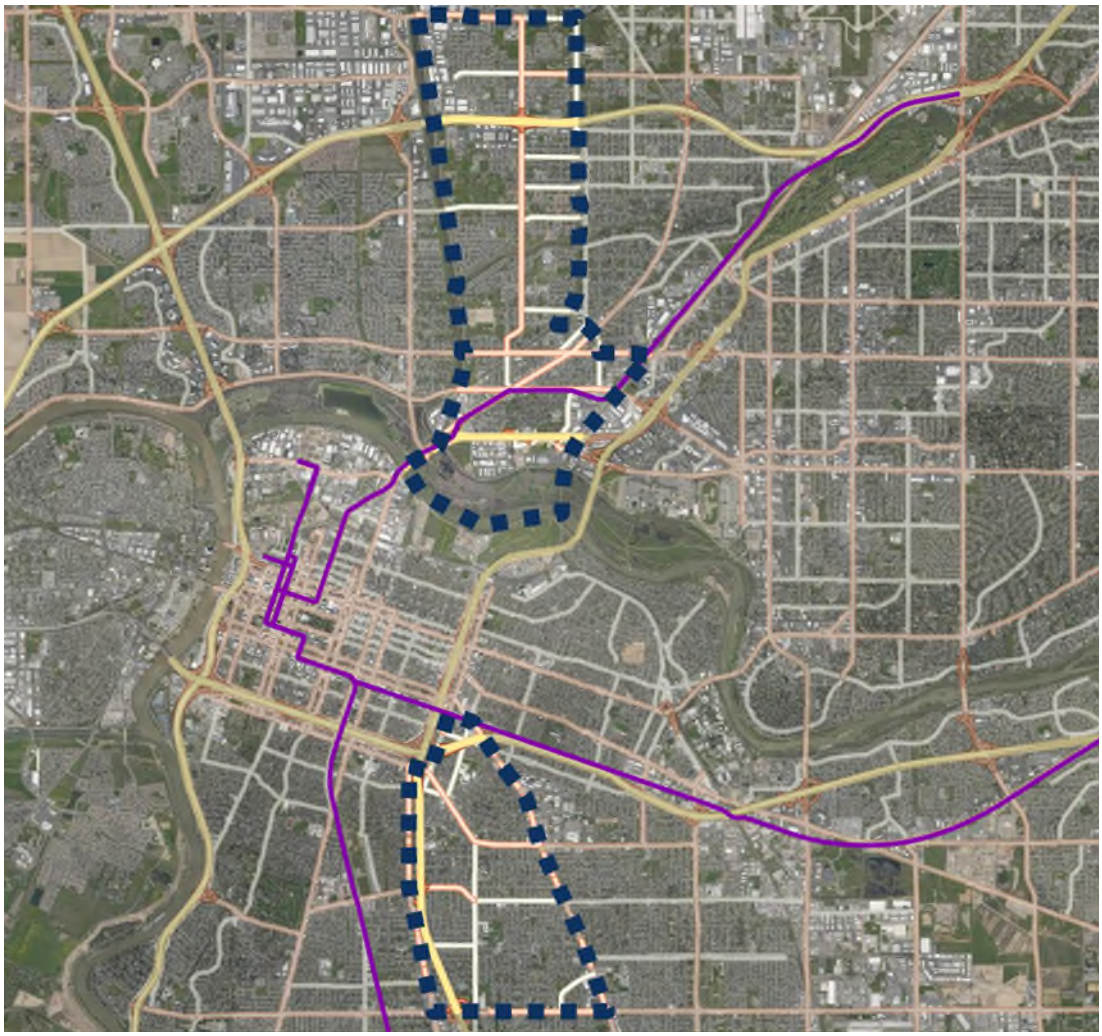


Figure 75 – Sacramento Neighborhoods Activating on Air Quality (SNAAQ) project areas (source: Valley Vision). North Sacramento: Bordered by Main Avenue in the North, Rio Linda Blvd and rail lines in the East, the American River in the South, and rail lines in the West. Oak Park: Bordered by R Street in the North, Stockton Blvd in the East, Fruitridge Road in the South, and Franklin Blvd and Alhambra Blvd in the West.

[94] Valley Vision, Community Air Protection. https://www.valleyvision.org/projects/community-air-protection/.

Sacramento Toxics from Wood Smoke Study

The District conducted a Toxics from Wood Smoke Study in Sacramento County communities from December 2016 – January 2017. The study was made possible with funding from a Community Scale Air Toxics Ambient Monitoring grant award provided by EPA.

The study focused on four research questions:

1. What are the concentrations of Hazardous Air Pollutants (HAPs) in various communities in Sacramento?
2. To what degree does wood smoke contribute to toxics in these communities?
3. Are disadvantaged communities disproportionately impacted by toxics from wood smoke?
4. Are there changes that can be made to the Sac Metro Air District's air quality outreach program to reduce toxics from wood smoke?

Results and conclusions from this study are presented in a final report available on the District website[95]. Key findings from the study include the following:

- Wood burning was not found to contribute to HAPs
- Fossil fuel–related HAPs and black carbon (BC) concentrations were highest in environmental justice (EJ) communities
- BC from wood burning was highest in non-EJ communities
- Phone survey results were consistent with study measurements
- Low-cost sensors were very reliable and useful to assess spatial differences in particulate matter
- Low-cost sensors are modestly accurate

In summary, although wood burning was not a significant source of HAPs, it was a significant source of $PM_{2.5}$. The study provided valuable data for the District to improve its ambient air monitoring network. Subtleties in traffic-related and residential wood smoke air pollutants were observed in the study which provided insight into the District network, most importantly particulate matter sampling. Also, in regard to public notification and dissemination of air pollution data, the District was able to improve the efficiency of its public communication process through results of survey data from within multiple environmental and non-environmental justice communities. In many ways, this study helped to propel the District towards national recognition and spark efforts in many other community-oriented programs such as those mentioned previously.

2021 Climate Implementation Work Plan in collaboration with the City of Sacramento.

The District is collaborating with the City of Sacramento (City) in its 2021 Climate Implementation Work Plan with the shared goals of advancing the commitments of the Mayors' Commission on Climate Change and other sustainability initiatives, especially those centered on equity and environmental justice. The District is working with the City to develop a multi-pronged innovative monitoring campaign

[95] Sacramento Metropolitan Air Quality Management District, Wintertime Air Toxics from Wood Smoke in Sacramento.
http://www.airquality.org/ProgramCoordination/Documents/Wintertime%20Air%20Toxics%20from%20Wood%20Smoke%20in%20Sacramento_Final%20Report.pdf.

that engages residents, develops new data, and compliments and benefits from other air pollution monitoring efforts currently underway in the region. The project involves the following elements:

- A one-time deployment of approximately 100 commercially available, portable AQ monitoring sensors for city residents, schools, and businesses who express interest in participating in the air monitoring campaign.
- The deployment of mobile on-road or airborne monitoring platforms for measurement of hyperlocal conventional air pollution to provide a high-quality snap-shot of ambient concentrations at significant spatial and temporal resolution for gaining a comprehensive understanding of pollutants and “block-by-block” pollution behavior, potentially including also the ability to identify emission source(s) identification and attribution.

The cumulative outcome of these efforts will be a much finer resolution picture of air pollution and position the City and the District to develop efforts for pollution reductions underpinned by a set of mutual clean air and climate goals.

Comprehensive Air Pollution Monitoring and the District Air Monitoring Network

All monitoring efforts serve to help meet the District vision and goals. The District is committed to providing regional leadership in protecting public health and the environment as well as increasing the public's role and responsibility in improving air quality. These efforts help to meet these goals by installing monitors with residents throughout the communities of Sacramento County. One result from these efforts is that it provides the District with valuable data and builds relationships which help identify areas that may require alternative or additional public outreach to protect the health of all residents. Another result of these monitoring efforts is that the data can be analyzed to help determine if there are regions or communities which show anomalous concentrations when compared to the federal air monitoring network. These irregularities can be investigated to determine if focused resources, such as community-scaled emission reduction or mitigation strategies or targeted enforcement, are needed.

Comprehensive monitoring also encourages the development and enhancement of diverse partnerships throughout the region. These partnerships can have lasting impacts on the air monitoring network, such as finding and securing suitable monitoring locations, providing additional resources and contact persons in the case of emergencies, and enabling opportunities for public education from District staff on all aspects of air quality. All of these results can have direct impacts on the air monitoring network, but they also represent a strong community-oriented direction the District is committed to take to continue to improve network effectiveness and viability and bring air quality data and awareness to all residents.

Summary and Recommendations

As defined in 40 CFR Part 58 Appendix D, the network is designed to meet three basic monitoring objectives: (1) provide air pollution data to the general public in a timely manner; (2) support compliance with ambient quality standards and emissions strategy development; and (3) support air pollution research studies. The following sections highlight how the District ambient air monitoring network meets these three objectives.

In this assessment, the analytical results were synthesized to evaluate the entire network. Each analysis has its own value but does not stand alone in providing recommendations to the network. Whenever changes are recommended to the ambient air monitoring network, there are many aspects of the network that must be considered by the District, CARB, and EPA; many of which are unquantifiable. Incorporated into these decisions is that they are all subject to funding and resource availability as well as EPA approval.

Pollutant-specific analyses were performed in this assessment and associated ranking of monitors were calculated. Table 89 summarizes the overall rankings of each station by pollutant (for pollutants with 2 or more sites).

Table 89 – Summary of overall rankings of each station by pollutant from pollutant-specific analyses. Sites ranked highest are shaded green.

Site Name	O_3	$PM_{2.5}$	PM_{10}	NO_2	CO	Pb	SO_2
Sacramento-Branch Center #2			2				
Sacramento-Bercut Drive		5		6	3		
Elk Grove-Bruceville	2	4		1			
Sacramento-Del Paso Manor	2	1	3	1	1	✓	✓
Folsom-Natoma St.	5	6		3			
North Highlands-Blackfoot	5		4	4	2		
Sloughhouse	4	3					
Sacramento-1309 T Street	1	2	1	4			

North Highlands-Blackfoot Removed from Analysis

Site Name	O_3	$PM_{2.5}$	PM_{10}	NO_2	CO	Pb	SO_2
Sacramento-Branch Center #2			2				
Sacramento-Bercut Drive		5		5	2		
Elk Grove-Bruceville	3	4		1			
Sacramento-Del Paso Manor	2	1	3	1	1	✓	✓
Folsom-Natoma St.	5	6		3			
Sloughhouse	3	3					
Sacramento-1309 T Street	1	2	1	4			

More detailed information on the conclusions for each pollutant can be found within the specific sections of this assessment. As shown in Table 89, two sites are ranked the highest from the five pollutants with more than one site. These sites are the Sacramento-Del Paso Manor and Sacramento-1309 T Street sites. The discontinuation of the North Highlands-Blackfoot station yielded no change to the highest site rankings. The monitors with the lowest total scores for each pollutant were examined carefully to identify network redundancies or possible relocation. The results of each of the analyses were evaluated in context of the overall monitoring objectives specific to each pollutant. Recommendations for the network were made based on the aggregated results of the analyses identified in the Technical Approach section. Below are the major recommendations from this assessment.

- Installation of a continuous PM_{10} monitor at the Elk Grove-Bruceville site.
- Installation of the Photochemical Assessment Monitoring Stations (PAMS) equipment required in 40 CFR Appendix D to Part 58 after the Sacramento-Del Paso Manor station expansion project is completed. The existing PAMS VOC canister sampling will be replaced with an automated gas chromatograph (autoGC). An ultraviolet radiation sensor, precipitation gauge, and barometric pressure sensor will also be installed.
- 40 CFR Part 58 requires state or local air monitoring organization to operate a second near-road monitoring site if any traffic count in the metropolitan area surpasses 250,000 in annual average daily traffic. The Sacramento area has surpassed the threshold for 2015-2019 data (2020 traffic volume fell below the threshold). The District is working with EPA and CARB to determine the appropriate timing, location, and funding for a second near-road monitoring site.

The recommendations for addition and removal of sites are described in the following sections.

Recommendations for Removal of Existing Site(s)

Based on the assessment of the District ambient air monitoring network, there is a single site that is recommended for removal or discontinuation. The recommendation for this site are concurrent with a replacement air monitoring station for the discontinued North Highlands-Blackfoot station and are as follows:

> Discontinue the Sacramento-Branch Center #2 PM_{10} monitor and the Sacramento-Branch Center #2 air monitoring station.

More detailed information on this recommendation can be found in the PM_{10} section of this assessment. No other sites are recommended for removal.

Recommendations for Addition of Site(s)

Based on the assessment of the District ambient air monitoring network, there are two recommendations.

1. The Sacramento MSA exceeded the traffic volume threshold for a second near-road monitoring site according to 40 CFR Part 58 (2015-2019 traffic volume data exceeded threshold, 2020 traffic volume fell below the threshold). The District is working with EPA and CARB to determine the appropriate timing, location, and funding for a second near-road monitoring site.

2. Installation of a replacement air monitoring station near the discontinued North Highlands-Blackfoot location to measure PM_{10} concentrations and if resources are available, ozone.

More detailed information on these recommendations can be found in the ozone, PM_{10}, and NO_2 sections of this assessment. There are no other recommendations for additional sites to the network.

Overall Satisfaction of Federal Air Monitoring Requirements

This assessment finds that most criteria pollutants meet or exceed federal air monitoring requirements as per 40 CFR Part 58. The only requirement not met is that the Sacramento MSA has surpassed the threshold for a second Near Road station. The District currently operates one Near Road station and is required to install a second Near Road station that would include two monitors, one to monitor nitrogen dioxide (NO_2) and the other carbon monoxide (CO). The District is working with EPA and CARB to determine the appropriate timing, location, and funding for a second Near Road monitoring site. The District currently meets all requirements for PAMS and meteorological measurements.

Future Priorities and Technologies

EPA is continuously working with state, local, and tribal agencies to improve ambient air monitoring networks through improved technologies. The ability of the District network to support air quality measurements and characterize pollution within Sacramento County is enhanced with incorporating new technologies. The following is a description of some upgrades in technology the District has incorporated into the network.

The District has migrated the database system from an older SQL 2012 server to a newer SQL 2019 server dedicated to the District air resources manager software. The new server (virtual machine) runs on windows server 2019 as opposed to 2012 Release 2.

The District has upgraded the primary $PM_{2.5}$ sampler at the Folsom-Natoma St. monitoring site to a newer sampler. The filter-based sampler at the Sacramento-Bercut Drive site was temporarily upgraded to an EPA approved FEM continuous $PM_{2.5}$ monitoring system on loan in December 2020 with a permanent similar sampler planned for installation when procured by the District. For PM_{10} sampling, continuous monitors are being considered for improved public information purposes and network efficiency.

The PAMS network has also been infused with new technologies concurrent with the revised PAMS requirements in 40 CFR Part 58. A ceilometer was installed at the Elk Grove-Bruceville site to provide much improved measurements of atmospheric mixing heights. Upon the completed construction of the Sacramento-Del Paso Manor station, an automated gas chromatograph (autoGC) system will be installed to sample continuous hourly-averaged speciated VOCs. The District is also considering improving the current nonmethane hydrocarbon samplers to newer technologies.

Over the previous few years, commercially available small sensors have become extremely popular globally. The technology in these small sensors is promising and when leveraged with existing networks, provide valuable information such as uses for smaller scale air quality forecasting and increase spatial air quality coverage during air quality events such as smoke from wildfires. The District has currently deployed this small sensor technology through multiple community air quality programs to sample $PM_{2.5}$, NO_2, O_3, and black carbon in communities most disproportionally impacted by air pollution.