State of Alaska
2020 Ambient Air Quality Network Assessment

July 1, 2020

Air Quality Division

Air Monitoring
&
Quality Assurance
Program

555 Cordova St

Anchorage, AK 99501

Phone: (907) 269-7577
Fax: (907) 269-7508

dec.alaska.gov

This page intentionally left blank

Executive Summary

The U.S. Environmental Protection Agency (EPA) requires state monitoring agencies to conduct a network assessment once every five years [40 CFR 58.10(d)]. The network assessment includes re-evaluation of the objectives and budget for air monitoring, an evaluation of a network's effectiveness and efficiency, and recommendations for network reconfigurations and improvements.

The Air Monitoring and Quality Assurance Program (AMQA) in the Department of Environmental Conservation's (DEC) Air Quality Division is responsible for planning and overseeing the State's monitoring network. The monitoring network focuses on criteria pollutants as prescribed by the Clean Air Act. The main pollutants of concern in Alaska currently are fine particulate matter ($PM_{2.5}$) and coarse particulate matter (PM_{10}), followed in order of importance by carbon monoxide (CO), lead (Pb), ozone (O_3), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2).

Air monitoring has historically focused on Alaska's largest population centers: the Municipality of Anchorage and Matanuska Susitna (Mat-Su) Borough, the Fairbanks North Star Borough (FNSB), and the City and Borough of Juneau. This is also where the regulatory monitoring sites have been established. Due to stagnant or decreasing funding for air quality assessments over the past ten years the program had to reduce the monitoring to the required regulatory sites based on EPA requirements for Core Based Statistical Areas (CBSAs). All air quality monitoring statewide, except for citizen science monitoring, regional haze (IMPROVE) monitoring, and industry monitoring for permit applications, is conducted by the State's AMQA program, consisting of 12 positions.

Alaska's ambient air quality issues focus on particulate matter. Almost every community in the state can be impacted by wildland fire smoke during the summer and road dust from gravel roads or other windblown dust. While other pollutants are also emitted into the atmosphere, the combination of comparatively small population centers, small number of stationary sources, the location and density of industries, and the lack of sun light to cause pollutant formation, result in lower concerns for the other criteria pollutants.

The current network consists of nine sites with 26 monitors. There are three sites each in the Fairbanks North Star Borough and the Municipality of Anchorage, and one site each in the Mat-Su Borough, the City and Borough of Juneau, and the community of Bethel.

Monitoring Objectives and Budget

Most of the DEC's air monitoring activities are focused around population centers and areas that have shown in the past to have air quality problems. The Mat-Su Borough population has been consistently growing over the past several decades and, as a result, DEC enlarged its monitoring network to three monitoring sites in this area in 2010. However, due to budget cuts and reduced staffing, DEC has had to consolidate some of its operations in recent years. Currently the only site remaining in the Mat-Su Borough is the Butte site ($PM_{2.5}$, PM_{10}). The current statewide ambient monitoring network now consists only of required regulatory sites with the exception of the Bethel Special Purpose Monitoring (SPM) site.

Network Effectiveness and Efficiency

While the monitoring network meets the regulatory requirement in terms of number of monitoring stations and monitored pollutants, it is confined to the population centers and does not adequately characterize conditions in outlying and rural communities.

Operation of the regulatory monitoring network is stable and meets all the federal requirements. DEC continues to focus on maintaining the core monitoring site operations and reporting data to the federal air quality database, AQS. Any additional special studies, special projects, wide spread monitoring in smaller communities or emergency monitoring for wildfires or volcanic eruptions proceed when staff time and funding allow.

New sensor technology has developed rapidly in recent years. These technology are seeing increased private use and DEC continually receives public requests for using and comparing these technologies to data collected at the regulatory monitoring sites. As a seasonal particulate matter monitoring network statewide is needed for natural events such as wildland fire smoke, opportunities lie with new portable, lower cost sensor technology.

Recommendations for Network Reconfigurations and Improvements

Based on the overall low number of industrial sources in the state and the low levels of manmade ambient pollution, DEC does not plan to expand the regulatory monitoring network. Regulatory monitoring stations are expensive and labor intensive.

Throughout the State there are only a few communities with populations between 1,000 and 10,000. These communities are often hub communities, i.e. regional transportation hubs that are served by larger commercial airlines and are jump off points to the smaller communities serviced either by smaller commercial airlines or private transport. Approximately one third of Alaska's population lives in small rural communities of less than 1,000 residents.

Community Based Monitoring

As funding becomes available, DEC plans to expand sensor pod technology into the hub communities to begin collecting baseline information across the state. These sensor pods can be customized according to the interest and concern in the community. All sensor pods would have a basic set of sensors that include particulate matter, SO_2, NO_2 and CO sensors. Where funding allows, meteorological sensors and volatile organic carbon sensors might be added. DEC will start working with our federal and tribal partners to establish and expand this network.

Smaller and cheaper sensor technology will be deployed to expand particulate matter monitoring for wildfire smoke strategically in smaller communities. This effort started in 2019 and was spearheaded by the University of Alaska Fairbanks, when approximately 30 PurpleAir sensors were set-up in rural areas all around the state. Due to the short lifespan of these low cost sensors (EPA estimates a life time of 1-3 years) keeping the sensor network functional and updated will be an ongoing commitment and could prove challenging.

Source specific monitoring

Cruise Ship Air Impacts

DEC is in the process of establishing a sensor network in Southeast Alaskan port communities. In 2019 DEC conducted a pilot study in downtown Juneau in response to rising public complaints regarding air emissions from cruise ships. The study did not find that impacts from cruise ship emissions to fine particulate matter concentrations rise to the level of concern, but it indicated that further investigation of gaseous pollutant impacts might be warranted. DEC was able to purchase a number of sensor pod samplers with the ability to measure SO_2, NO_2, and CO in addition to particulate matter and some meteorological parameters on an hourly basis. The equipment will initially be tested in Juneau with the intent to expand the network into the major cruise ship port communities in Southeast Alaska and further into Southcentral Alaska.

Wildland fire Smoke

As predictions for more frequent and severe fire seasons increase, a stable and long term seasonal or year round monitoring network is needed to better inform the affected public and aid in smoke forecasting. If DEC is successful at establishing a community based low cost sensor network, it may serve to meet the need for a wildland fire smoke network.

Air Toxics program

This monitoring assessment does not address air toxics since Alaska does not have an Air Toxics Program anymore. It was shut down in the early 2000s due to budget cuts. Since then, some short term studies have been undertaken in various areas, and a number of air toxic pollutants remain of concern in Alaska's largest municipality. Any future air toxics monitoring in the state would likely require federal funding.

The Fairbanks North Star Borough has been in nonattainment for $PM_{2.5}$ since 2009. The main component in $PM_{2.5}$ in this area is organic carbon and wood heat is believed to be the dominant source. Wood smoke contains many toxic components, but DEC has no information about air toxics levels in the community and the area would be a prime location for the addition of a National Air Toxics Trend site (NATTS).

Another area that has consistently requested air toxic sampling is within the North Slope Borough. As oil and gas development expands to areas closer to communities, the public concern about volatile organic compounds (VOCs) and other air toxics increases.

Other considerations

Over the years, monitoring activities that are not specifically targeting a regulatory monitoring site have been delayed or deferred. Dedicated funding and staff expertise is required for some of these activities, like building a wireless communication device or a specialized air sensor pod. The lack of a well-developed internet or even cell phone infrastructure makes data telemetry either very expensive when using off-the-shelf systems that require satellite transmission and often do not work well in Alaska's isolated communities.

Widespread data dissemination capabilities are another necessity that has been delayed. DEC is working on developing an application for disseminating air quality information and advisories via text messages and emails statewide. Currently DEC has a contract with a media company to distribute the air alerts generated during elevated wintertime pollutant levels within the FNSB nonattainment area.

Table of Contents

List of Tables

List of Figures

List of Acronyms

AMQA:	Air Monitoring and Quality Asurance Program
AQS:	Air Quality System
ATV:	All Terrain Vehicle
CAA:	Clean Air Act
CBJ:	City and Borough of Juneau
CBSA:	Core Base Statistical Area
CFR:	Code of Federal References
CO:	Carbon Monoxide
DEC:	Department of Environmental Conservation
DOT:	Department of Transportation
EPA:	Environmental Protection Agency
FEM:	Federal Equivalent Methode
FNSB:	Fairbanks North Star Borough
FRM:	Federal Reference Method
FWS	U.S. Fish and Wildlife Service
IMPROVE:	Intergaceny Monitoring of Protected Visual Environments
LIMS:	Laboratory Information Management System
Mat-Su:	Matanuska- Susitna Borough
mg/m^3:	milli grams per cubic meter
Microns:	Micrometer, 1 millionth of a meter
MSA:	Metropolitan Statistical Area
MTL:	Measurement Technologies Laboratory
NAAMS:	National Ambient Air Monitoring Strategy
NAAQS:	National Ambient Air Quality Standard
NATTS:	National Air Toxics Trends Sites
NCore:	National Core Site
NO_2:	Nitrogen Dioxide
O_3:	Ozone
Pb:	Lead
PM_{10}:	Particulate Matter with an aerodynamic diameter less than 10 micrometers
$PM_{2.5}$:	Particulate Matter with an aerodynamic diameter less than 2.5 micrometers
ppb:	parts per bilion
ppm:	parts per million
QA/QC:	Quality Assurance/Quality Control
RadNet:	Radiation Monitoring Network
SCC:	Sharp Cut Cyclone
SO_2:	Sulfur Dioxide
SPM:	Special Purpose Monitoring
TAPS:	Trans Alaska Pipeline System
TSP:	Total Suspended Particle
UAF:	University of Alaska Fairbanks
VOC:	Volitile Organic Carbon
VSCC:	Very Sharp Cut Cyclone
$\mu g/m^3$:	micro grams per cubic meter

1. Background

The U.S. Environmental Protection Agency (EPA) finalized an amendment to the ambient air monitoring regulations on October 17, 2006. As part of this amendment, the EPA added the following requirement for state, or where applicable local, monitoring agencies to conduct a network assessment once every five years [40 CFR 58.10(d)].

> *"(d) 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 PM2.5, 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."*

This requirement is an outcome of implementing the National Ambient Air Monitoring Strategy (NAAMS, the most recent version is dated December 2005, U.S. Environmental Protection Agency, 2005). The purpose of the NAAMS is to optimize U.S. air monitoring networks to achieve, with limited resources, the best possible scientific value and protection of public and environmental health and welfare.

A network assessment includes (1) re-evaluation of the objectives and budget for air monitoring, (2) evaluation of a network's effectiveness and efficiency relative to its objectives and costs, and (3) development of recommendations for network reconfigurations and improvements. EPA expects that a multi-level network assessment will be conducted every five years (U.S. Environmental Protection Agency, 2005).

2. Introduction

In 1970 the Congress of the United States created the U.S. Environmental Protection Agency (EPA) and promulgated the Clean Air Act (CAA). Title I of the Clean Air Act established National Ambient Air Quality Standards (NAAQS) to protect public health. NAAQS were developed for six *criteria pollutants*: total suspended particulate matter (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and lead (Pb). Subsequent revisions to the particulate matter standard resulted in two new standards: PM_{10} and $PM_{2.5}$. The first revision (1987) reduced the size of particulate matter that was considered harmful to humans, measuring for particles less than 10 micrometers (or microns) in diameter (PM_{10}). That standard was later revised (1997) to separate the PM_{10} size particles into two size fractions: coarse and fine. The coarse particulate matter fraction represents particles between 10 and 2.5 microns and fine particulate matter represents particles 2.5 micron and smaller in diameter ($PM_{2.5}$).

Threshold limits established under the NAAQS to protect health are known as primary standards. The primary health standards are set to protect the most sensitive of the human population, including those people with existing respiratory or other chronic health conditions, children, and the elderly. Secondary standards established under the NAAQS are set to protect the public welfare and the environment. The CAA instructs EPA to periodically review and revise the NAAQS based on the assessment of national air quality trends and on current and ongoing health studies.

EPA delegated the authority to manage air quality to the states. In Alaska, the Air Quality Division of the Department of Environmental Conservation (DEC) has been evaluating ambient air quality in Alaska since the late 1970s. DEC adopted the NAAQS, but also established its own Alaska Ambient Air Quality Standards (AAAQS) in addition to the federal standards. Table 1 contains the current NAAQS and AAAQS.

EPA created rules and guidance for establishing and maintaining monitoring networks. Requirements for the number of sites in an area depend on a variety of factors, chiefly among them are the ambient concentrations for the specific pollutant and the population numbers. Due to the small population even in our largest metropolitan areas, many of the monitoring requirements triggered by population numbers do not apply to Alaska.

The Air Monitoring and Quality Assurance Program (AMQA) in DEC's Air Quality Division is responsible for planning and overseeing the State's monitoring network. The main pollutants of concern in Alaska currently are $PM_{2.5}$ and $PM_{10,}$ followed in order of importance by CO, Pb, O_3, $SO_{2,}$ and NO_2.

To assess the adequacy of the existing network, AMQA has to review the current and projected economic conditions throughout the state and as well as the projected population growth. The following chapters will describe these factors, alongside a summary of the distinct ecosystems in the state based on climate and topography, followed by a discussion of the current air quality and the current monitoring strategy.

Table 1. National and Alaska Ambient Air Quality Standards (NAAQS and AAAQS)

Pollutant		NAAQS/ AAAQS	Averaging Time	Level	Form
Carbon Monoxide (CO)		NAAQS	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		NAAQS	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		NAAQS	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		NAAQS	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		NAAQS	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	NAAQS	1 year	12.0 µg/m^3	annual mean, averaged over 3 years
		NAAQS	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	NAAQS	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		NAAQS	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		AAAQS(5)	3 hours	0.5 ppm	Not to be exceeded more than once per year
		AAAQS(5)	24 hours	0.14 ppm	Not to be exceeded more than once per year
		AAAQS(5)	annual	0.030 ppm	Annual Mean
Ammonia (NH3)		AAAQS	8 hours	2.1 mg/m^3	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

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

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

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

(5) The State of Alaska retained the previous SO_2 NAAQS, even after 2010, when EPA rescinded the NAAQS for the 24-hour and annual averaging period, and lowered the 3 hour averaging period from a primary to a secondary standard.

3. Alaska's Geography, Climate, Topography, and Economy

Geography and Climate

Alaska comprises one sixth of the United States landmass and has a population density of 1.2 persons per square mile. The state spans 20 degrees of latitude (51°N – 71°N) and 58 degrees of longitude (130°W – 172°E) and contains 65% of the U.S. continental shelf, more shoreline than the rest of the 49 states combined, 17,000 square miles of glaciers, 3,000,000 lakes that are over 20 acres in size, and receives 40 % of the U.S. fresh water runoff. Figure 1 shows a map of Alaska and the diverse climate regions described below.

The **Panhandle** is a temperate rain forest in the southeastern part of Alaska that mainly comprises mountainous islands and protected marine waterways. Rainfall exceeds 100 inches per year in many areas. Most communities are small and have less than 5,000 year-round residents. Juneau, the State's capital, is the largest city in the region with a population of approximately 32,000.

The **South Gulf Coast** is one of the wettest regions in the world. Yakutat receives over 150 inches of non-thunderstorm rain per year and Thompson Pass averages over 700 inches of snow annually. The area is covered with rugged mountains and barren shoreline and is the target of many Gulf of Alaska storms. This coastline contains a handful of small fishing communities.

Figure 1. Map of Alaska - the majority of the Aleutian Islands (west) is omitted.

Southcentral Alaska is fairly temperate in comparison to the rest of Alaska. Rainfall varies widely across the region, averaging between 15 inches per year in the Matanuska-Susitna (Mat-

Su) Valley and 60 inches per year in Seward. This region contains 60% to 70% of the state's population with Anchorage, the state's largest city, home to 292,000 people. Bounded by active volcanoes on the southwest and glacial river plains to the northeast, this sector of the state has experienced 24-hour dust levels in excess of 1,000 $\mu g/m^3$.

The **Alaska Peninsula** and its westward extension, the Aleutian Chain, form the southwestern extension of the mountainous Aleutian Range. This region comprises remote islands and small, isolated fishing villages. This area is one of the world's most economically important fishing areas, as well as a vital migratory route and nesting destination for birds.

Southwest Alaska encompasses the vast Yukon-Kuskokwim River Delta, a wide low-lying area formed by two of the state's major river systems and dotted with hundreds of small lakes and streams. This region is heavily impacted by storm systems which rotate northward into the Bering Sea. Communities in this region receive between 40 and 70 inches of precipitation each year. This portion of the state is quite windy, experiencing winds between 15 – 25 miles per hour throughout the year. These winds, coupled with fine delta silt, help to create dust problems for some southwestern communities. Rural villages normally contain fewer than 500 people and are located along the major rivers and coastline. Regional hub communities, such as Bethel (SW Alaska), may have up to 6,100 residents.

Interior Alaska describes the vast expanse of land north of the Alaska Range and south of the Brooks Range. This region contains Fairbanks, Alaska's second largest city, with a population approaching 32,000 people (95,898 in the borough). The climate varies greatly with clear, windless, -50°F winter weather giving way to summer days with 90°F temperatures and afternoon thunderstorms. Sectors of this region also experience blustery winds and high concentrations of re-entrained particulates from open riverbeds.

The **Seward Peninsula** is the section of Alaska which extends westward into the Bering Sea between Norton Sound and Kotzebue Sound. This hilly region is barren and windswept with 15-25 mile per hour winds common. Rainfall in this region averages between 15 and 24 inches per year. Villages in this region are small except for Nome which has over 3,000 people.

The **North Slope** region, located north of the Brooks Range, is an arctic desert receiving less than ten inches of precipitation annually. Wind flow is bimodal, with the easterlies dominating the meteorological patterns. Winter wind speeds average 15-25 mile per hour dropping off slightly during the summer. The North Slope is extremely flat and supports huge summertime populations of bears, caribou, and migratory birds.

Topography

Alaska topography varies greatly and includes seven major mountain ranges which are significant enough to influence local and regional wind flow patterns. The mountains channel flow, create rotor winds, cause up slope and down slope flow, initiate drainage winds, produce wind shear and extreme mechanical turbulence. For air quality impact analyses, Alaska's rugged mountains can only be described as complex terrain making many air quality models unsuited for use in the state. The complexity of most local meteorology renders the use of non-site specific meteorological data inadequate for most control strategy development.

In addition to mountains, Alaska has several deserts, some north of the Arctic Circle, extensive wetlands, numerous glaciers, and large deep fjords with very high tides and strong tidal currents. Local wind flow patterns along the coast and near large lakes may be influenced by land/sea breezes.

Economy

The Alaskan economy is centered on the oil industry, the mining industry, commercial fishing, logging, and tourism. Of the five, only the oil and mining industries provide a year-round source of income to the state and these industries typically require the full time operation of stationary power generation equipment.

Alaska's oil and natural gas development is concentrated on leases located primarily on the North Slope and in and around Cook Inlet. The state's oil industry operates production wells in Cook Inlet and on the North Slope. North Slope oil is pumped 800 miles through the Trans-Alaska Pipeline System (TAPS) to Valdez for shipment to refineries in the lower 48 states. The TAPS has several pump stations to maintain the flow of oil in the pipeline. The majority of new oil exploration work is being conducted on the North Slope. Petro Star has two in-state refineries in Valdez and North Pole that process small amounts of North Slope crude. Cook Inlet crude is processed at the Marathon Petroleum refinery in Nikiski, located near Kenai, Alaska. The oil and natural gas sector provides royalties, rents and taxes the state depends on for its operating and capital budget. Oil and gas revenue had long accounted for 80% or more of the State of Alaska general fund revenues, supporting a broad range of public services. However, starting in 2014, declining oil prices resulted in a sharp drop in revenue to the state from this sector. In fiscal year 2019, the oil and gas industry taxes and royalties provided 40% of the unrestricted general fund revenue available for appropriation.

(https://www.aoga.org/sites/default/files/mcdowell_group_aoga_report_final_1-24-2020.pdf)

Mining is a stable employment sector in Alaska. Total mineral industry employment in 2016 is estimated at 2,727 full-time equivalent jobs. The value of the industry is well over $1 billion annually and is expected to grow over the coming decade. (https://laborstats.alaska.gov/trends/oct18art1.pdf) The state has six large lode mines and an estimated 241 placer operators. The large mines are the Teck Resources Ltd.-NANA Red Dog Mine (zinc, lead, silver) near Noatak, the Coeur Alaska Inc. Kensington complex (gold) between Juneau and Haines, the Hecla Mining Greens Creek mine (silver, gold, zinc, lead) near Juneau, the Kinross Gold Fort Knox Mine (gold) near Fairbanks, the Northern Star Pogo Mine (gold) near Delta Junction, and the Usibelli Mine (coal) near Healy. Numerous other small mining ventures exist across the state (Athey, et al., 2013). (https://www.commerce.alaska.gov/web/ded/DEV/MineralsDevelopment/MineralsProduction.aspx).

Alaska's timber industry, another important economic sector, has been in decline in recent years. In the 1970s, forest products were the second largest industry in the state. Timber has been exported as logs, lumber and timbers into the Pacific Rim for the past five decades and for many years, lower quality timber was used to produce pulp for the world market. With shifts in land use, political and economic pressure, the industry has been in decline since the 1990s. Commercial logging has primarily taken place in the coastal zone including the 16.8 million acre

Tongass National Forest and Native corporation land in Southeast and coastal Southcentral Alaska. The Chugach National Forest in Southcentral Alaska is the nation's second largest national forest with 4.8 million acres. Timber harvests also occur on state "boreal" forest lands in Interior Alaska, which is experiencing slow, but steady growth as wood biomass projects are developed to meet community needs for economic space heating and electrical generation. (https://www.akrdc.org/forestry)

Tourism is also a major sector of Alaska's economy attracting over a million visitors annually. Spending by visitors drives the economy creating jobs and income in a wide variety of sectors including transportation, retail, and lodging. In 2013-14, total employment in Alaska's visitor industry was estimated at 38,700 jobs across the state representing 8 percent of statewide employment in 2013-14, and 4 percent of statewide labor income. The role of tourism is particularly important in the Southeast region where it accounts for 20% of employment and 13% of labor income. (https://www.commerce.alaska.gov/web/Portals/6/pub/TourismResearch/AVSP/2013_2014/Vis%20Industry%20Impacts%202013_14%203_24.pdf).

The seafood industry contributes to roughly 60,000 jobs and approximately $5.6 billion in total economic activity in Alaska (2017-2018). Each year 5 to 6 billion pounds of seafood are harvested. Alaska seafood was sold in 97 countries around the world in 2018. Export markets typically account for approximately two-thirds of sales value, while the U.S. market buys the remaining one-third. Commercially important seafood species include salmon, crab, pollock, halibut, cod, and flatfish which account for 90% of Alaska's ex-vessel value of seafood. (https://uploads.alaskaseafood.org/2020/01/McDowell-Group_ASMI-Economic-Impacts-Report-JAN-2020.pdf) .

4. Alaska's Population

Alaska comprises one sixth of the United States landmass and has a population density of 1.3 persons per square mile. The 2010 census map (Figure 2) illustrates the actual population distribution across the state. There are vast stretches of the state having less than 1.0 persons per square mile and a few small areas with approximately 8,000 persons per square mile.

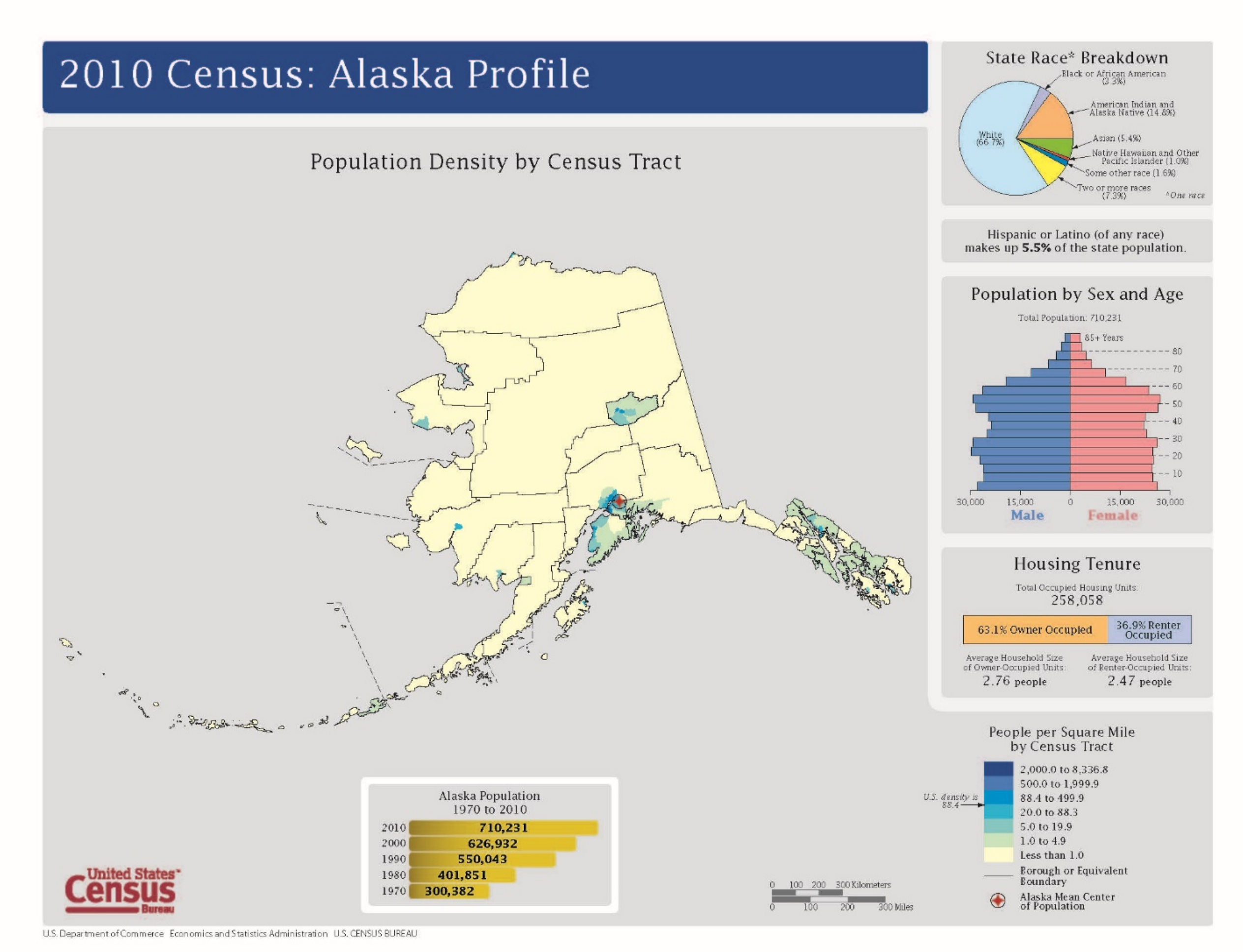


Figure 2. 2010 Census profile map for Alaska

The 2010 census numbers show the state's total population at 710,231 (In 2019, the population is estimated at 731,007). Roughly half of Alaska's residents live in Anchorage and the surrounding communities of the Matanuska – Susitna Valley (Table 3). The state has one medium-sized, core-based statistical area comprising the Municipality of Anchorage (the central unit of this CBSA) and the communities of Wasilla and Palmer (the outlying portion of the CBSA) (Figure 3). The Fairbanks North Star Borough in the interior of Alaska is the second largest population center and a small CBSA. The Juneau City and Borough and Ketchikan Gateway Borough, in

Southeast Alaska, are both micropolitan areas. Approximately one fourth of Alaska residents live outside a CBSA.

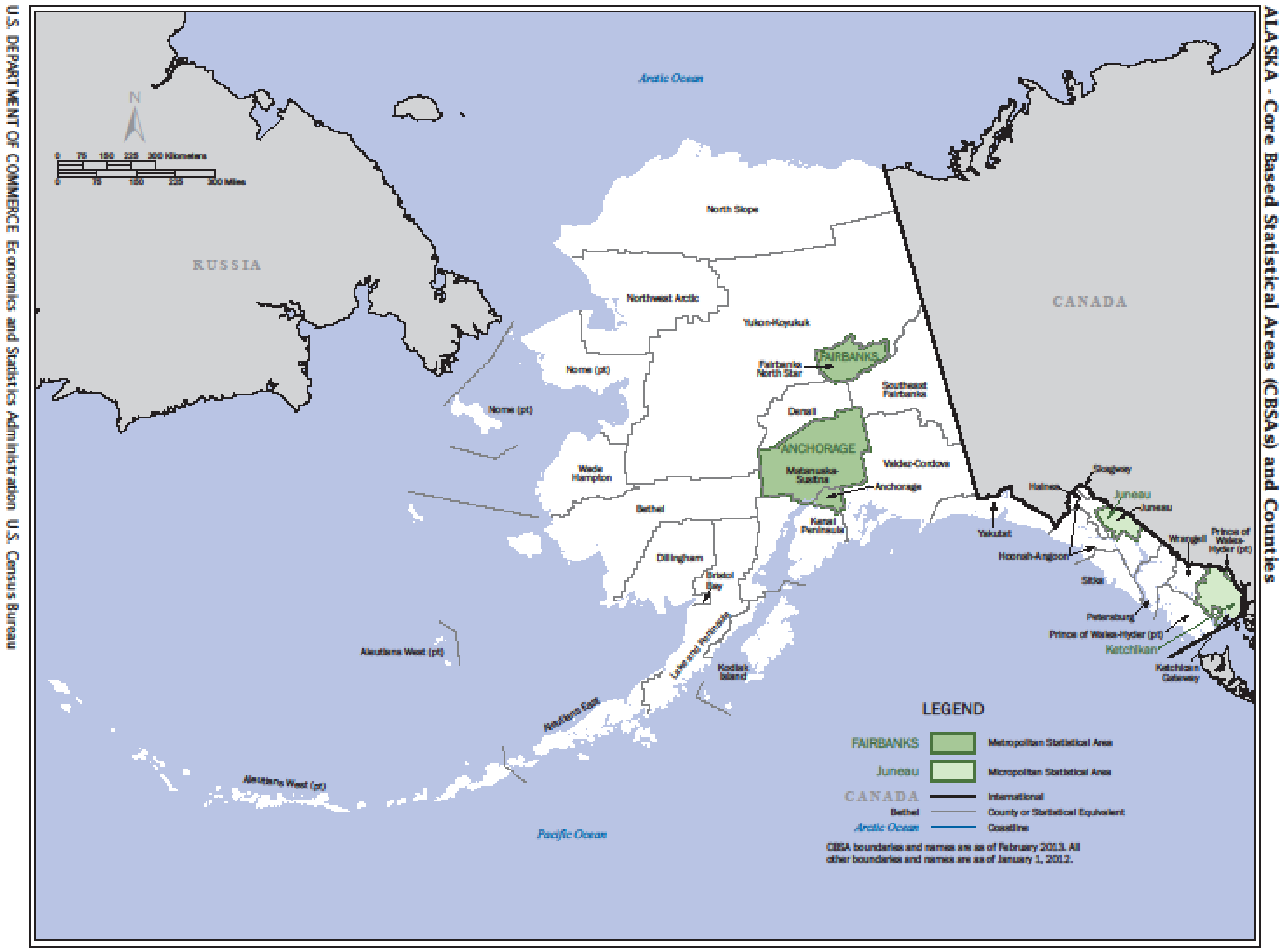


Figure 3. Alaska Core Based Statistical Areas (CBSA) and Counties (US Census Bureau)

Table 2. Alaska CBSA populations and categories. Metropolitan and micropolitan statistical areas are delineated by the US Office of Management and Budget using 2010 US Census Bureau data.

Community		Population	Total	CBSA category
Anchorage	Anchorage Municipality (Anchorage MSA)	297,826	380,821	Metropolitan (Medium CBSA)
	Matanuska-Susitna Borough (Anchorage MSA)	88,995		
Fairbanks North Star Borough			97,581	Metropolitan (Small CBSA)
Juneau City and Borough			31,275	Micropolitan
Ketchikan Gateway Borough			13,477	Micropolitan
All other areas			168,035	Outside of CBSA

Table 2 summarizes the 2010 population distribution among the six major Alaska population regions (http://live.laborstats.alaska.gov/pop/projections/pub/popproj.pdf). In 2018, eighty percent of Alaska's residents lived in communities with population of 2,500 or more (http://live.laborstats.alaska.gov/pop/estimates/pub/18popover.pdf). The Alaska Department of Labor and Workforce Development projects the highest growth rate within the state to occur in the Matanuska- Susitna Borough (40% increase between 2015 and 2045). DEC had enlarged its monitoring network to three monitoring sites in this area in response to population increases in 2010. However due to budget cuts and reduced staffing, DEC consolidated some of its operations by decommissioning the Wasilla site in March 2015 and the Palmer site in 2019. The site in Butte ($PM_{2.5}$, PM_{10}) remains operational and is intended to remain in the monitoring network for the long term.

Table 3. Alaska Population by Region, Borough, and Census Area, 2019 to 2030

	July 1, 2019 Estimate	July 1, 2020 Projection	July 1, 2025 Projection	July 1, 2030 Projection
Alaska	731,007	731,566	753,360	771,767
Anchorage/Mat-Su Region	**398,283**	**398,235**	**413,267**	**427,021**
Anchorage, Municipality	291,845	290,406	295,779	299,883
Matanuska-Susitna Borough	106,438	107,829	117,488	127,138
Gulf Coast Region	**80,866**	**80,989**	**82,491**	**83,637**
Kenai Peninsula Borough	58,367	58,671	60,606	62,230
Kodiak Island Borough	13,001	12,910	12,635	12,334
Valdez-Cordova Census Area	9,498	9,408	9,250	9,073
Interior Region	**109,847**	**110,822**	**114,389**	**116,315**
Denali Borough	1,860	1,819	1,850	1,880
Fairbanks North Star Borough	95,898	97,080	100,724	102,754
Southeast Fairbanks Census Area	6,891	6,823	6,886	6,924
Yukon-Koyukuk Census Area	5,198	5,100	4,929	4,757
Northern Region	**27,432**	**27,359**	**27,915**	**28,597**
Nome Census Area	9,831	9,812	9,977	10,193
North Slope Borough	9,886	9,905	10,200	10,544
Northwest Arctic Borough	7,715	7,642	7,738	7,860
Southeast Region	**72,373**	**72,118**	**72,098**	**71,749**
Haines Borough	2,516	2,471	2,455	2,435
Hoonah-Angoon Census Area	2,145	2,122	2,074	2,028
Juneau, City and Borough	31,986	32,000	32,273	32,374
Ketchikan Gateway Borough	13,739	13,709	13,711	13,652
Petersburg Borough	3,226	3,229	3,176	3,099
Prince of Wales-Hyder Census Area	6,194	6,140	6,047	5,946
Sitka, City and Borough	8,532	8,407	8,289	8,130
Skagway, Municipality	1,095	1,094	1,168	1,232
Wrangell, City and Borough	2,400	2,402	2,385	2,356
Yakutat, City and Borough	540	544	520	497
Southwest Region	**42,206**	**42,043**	**43,200**	**44,448**
Aleutians East Borough	2,938	2,935	2,911	2,884
Aleutians West Census Area	5,579	5,386	5,348	5,339
Bethel Census Area	18,131	18,162	18,844	19,596
Bristol Bay Borough	869	829	807	775
Dillingham Census Area	4,887	4,893	4,924	4,957
Kusilvak Census Area	8,180	8,184	8,676	9,181
Lake and Peninsula Borough	1,622	1,654	1,690	1,716

5. Meteorological Summary

Statewide Meteorology

Alaska experiences some of the most diverse weather patterns in the world. On any given day, temperatures across the state may vary by more than 100° F, winds may exceed hurricane force, it may be snowing on the North Slope, and raining in the Panhandle. Driven by the position of the Polar Jet Stream, Alaska's weather may be influenced by strong North Pacific lows or a ridge of very high pressure over the Interior. When coupled with Alaska's complex topography, large temperature swings (both daily and seasonally) and large variation in daylight (zero to twenty-four hours), the resulting synoptic/micro-scale weather frequently causes or contributes to most, if not all, pollution events detected in the state.

Alaska's weather falls into four general climatic zones: (1) a maritime zone which includes Southeast Alaska, the South Central Coast, and the Aleutian Islands; (2) a maritime continental zone which includes the western portions of Bristol Bay and Southwest Alaska where summer temperatures are moderated by the Bering Sea, but winter temperatures act more "continental" due to the presence of sea ice; (3) a continental zone which starts north of the coastal mountains and east of the maritime-continental zone and includes most of Interior Alaska, and (4) an arctic zone which covers Northwest Alaska and the Arctic slope. Each one of these climate patterns causes weather which has the potential to contribute to an air pollution event by: drying out the surface layer and enhancing the potential for forest fire activity (fine particulates), increasing area-wide winds and causing dust to be blown high into the air (coarse particulates), increasing local winds which produce mechanically re-entrained dust (coarse particulates), or through the development of strong temperature inversions which trap pollution close to the ground (fine particulates and carbon monoxide).

In general, most of Alaska's weather is driven by two inter-related meteorological features: the position of upper level highs and lows and the tracking of the polar jet which is responsible for steering surface weather patterns across the North Pacific and into Alaska. During the summer months when the jet stream tracks further north, surface lows often rotate up through South Central Alaska into the Interior. In the winter, the jet often positions itself further south allowing high pressure to dominate a majority of Alaska's weather, especially in the Interior where temperatures frequently drop below minus fifty degrees Fahrenheit. As these pressure features move and develop, they may intensify north-south pressure gradients producing high winds [increasing entrainment of anthropogenic (man-made) or natural dust] or weaken the regional flow helping to intensify strong surface inversions which trap air pollution (smoke, carbon monoxide, ozone) close to the ground. As a result, the statewide meteorology has played a large role in most of Alaska's previously documented air pollution events, including some violations of the NAAQS.

Air Pollution and Meteorology

A good knowledge of the local and regional meteorology is a key element in understanding air pollution episodes and how to implement effective control strategies which will protect the public. While some air pollution events are man-made (community generated dust, industrial pollution) many would not occur without a direct contribution from the weather. Alaska did not have a large number of automobiles in Anchorage or Fairbanks during the 1980s and 1990s, yet both communities exceeded the federal standard for airborne carbon monoxide during periods of strong winter inversions. Similarly, winter inversions have helped create high levels of smoke in Juneau and the Fairbanks North Star Borough as residents use wood or other solid fuel burning devices to heat their homes. Since the rise in fuel oil home heating costs in 2008/9, people are continuing to re-discover the wood-fired heater. While providing independence during emergencies and guaranteeing back-up heat, these units are not always energy efficient and create smoke. As the number of wood-fired heating sources increase, the concentration of smoke increases, especially on cold, clear winter nights. These emissions have the potential to exceed the air quality standards that were developed to protect public health.

Alaska's high winds are notorious for scouring fine material off hillsides and river beds creating dust storms which obscure visibility and impact public health. Regional winds, while not directly causing pollution events, do transport dust and wood smoke tens to hundreds of miles away from their sources, impacting public health. Ash from volcanic eruptions as well as sulfur dioxide plumes can travel far distances.

Most rural communities do not have paved streets and road dust is the most often noted air quality concern in small communities all across the state. The problem is not as severe in the larger cities. However, in addition to urban gravel roads winter sanding materials often become ground up due to traffic and create road dust problems in the spring.

Luckily, Alaska does not have many major pollution sources in close vicinity of communities. The sources that do exist are controlled under air pollution permits that closely regulate their air emissions. At present, all major anthropogenic sources in the Cook Inlet Basin, the most populated area of the state, are in compliance with the air quality standards and their emissions do not travel towards other populated areas with significant pollution sources. While the impact from anthropogenic sources is believed to be minimal (not exceeding the NAAQS), Alaska does have major sources of air pollution: wildland fires, windblown dust from natural sources of crustal materials, and particle emissions from volcanic eruptions, all of which are uncontrollable.

Core Based Statistical Area (CBSA)

When a controllable pollution event occurs repeatedly, the state is required to develop a control strategy which will lower emissions to an acceptable level. To better control sources of air pollution and minimize impact on the public, the US EPA has developed an enhanced control strategy for states which groups adjacent communities with similar man-made pollution sources into a Core Based Statistical Area (CBSA). The intent is to make sure that if elevated levels of pollution exist, the control strategy is effective and includes all contributing sources. In Alaska, where most communities are small and separated significantly by geography, the practicality of employing the CBSA concept to fix a localized air pollution problem does not make sense, in most cases. For the few locations where multiple communities lie adjacent to each other e.g., Fairbanks North Star Borough (City of Fairbanks, North Pole, Fort Wainwright and Eielson AFB), the Upper Cook Inlet Basin (Municipality of Anchorage, Girdwood, Eagle River, Chugiak, Wasilla, and Palmer) and the Northern Kenai Peninsula (Nikiski, Kenai, and Soldotna), either the meteorology does not necessarily support the need for development of a CBSA or the multi-community airshed is already being legally controlled.

Fairbanks North Star Borough: All of the communities and associated man-made sources of pollution are contained in the Borough. The Borough has legal and governing authority over the area making the development of a CBSA unnecessary. At present, the greater Fairbanks area is designated in nonattainment with the 24-hour $PM_{2.5}$ standard in the winter when strong inversions help to trap air pollution close to the ground. The Fairbanks North Star Borough nonattainment area boundaries include the cities of Fairbanks and North Pole, and Fort Wainwright, but not Eielson Air Force base. Over the past ten years, control strategies have resulted in a downward trend in $PM_{2.5}$ concentrations in Fairbanks, and within the last 5 years in North Pole as well, although the North Pole area still experiences extreme wintertime pollution. The State of Alaska continues to refine an effective control strategy.

Northern Kenai Peninsula (Nikiski, Kenai, Soldotna): Flow on the northwest coast of the Kenai Peninsula is similar to that observed in Anchorage, primarily north-south. While southerly winds seem to occur at a similar frequency, Kenai experiences twice as many northerlies, probably because it lies forty miles of longitude west of Anchorage and experiences the northerly drainage winds coming down the west side of the Basin. The Kenai winds differ greatly from those observed in Soldotna, which exhibit a much weaker flow that is more east-west and somewhat terrain induced. In general, the meteorological flow pattern for the peninsula does not suggest that these communities be considered a CBSA or be added to any other community to form one.

Upper Cook Inlet Basin (Anchorage, Elmendorf Air Force Base (AFB), Wasilla, Palmer): Flow in the upper basin is generally bi-modal with the strongest flow due to northerly drainage winds and southerly storm flow. The combination of these winds with the region's mountainous terrain create a pattern which is not conducive for transporting anthropogenic pollution from one community to the others. In addition, there are no major industrial sources north of Anchorage and all of the existing sources are in compliance with the NAAQS and air quality increments. The region has had some air pollution problems in the past, but those have been very localized (road dust, carbon monoxide, and wood smoke) and not transported between communities. The only transport of pollution into Anchorage occurred in the mid-1980s when the state allowed farmers at Point Mackenzie to the north of Anchorage, to burn slash from land clearing. The region does have occasional, naturally occurring pollution events (volcanic eruptions, wildland fire smoke, windblown dust from the river drainages, episodic Asian dust events) for which the state issues air quality advisories as necessary, but which are not controllable.

The Municipality of Anchorage is a good example of how different the local flow can be. In Girdwood (south end of the Municipality) and Chugiak/Birchwood (northeast side of the Municipality) weather conditions are often completely different from each other. At the same time, their winds do not represent those observed at Anchorage's airport, just to west of downtown. A dust event in east Anchorage does not normally equate to one in south Anchorage, Girdwood or Palmer. On the other hand, smoke from wildland fires in the Interior of Alaska can be transported into Anchorage or across greater distances. The windroses in Figures 4 through 7 for Anchorage, Elmendorf AFB (Part of Joint Base Elmendorf Richardson, east of downtown), Wasilla, and Palmer show how different the wind patterns are.

Based on the State's analysis of local and regional meteorology which examined annual wind rose data (Figures 4 - 7), short term wind events, the location of major anthropogenic sources of pollution, and emissions modeling for the major sources of pollution, Alaska is not planning to create CBSAs for any portion of the state as a method for controlling man-made air pollution events in the state. Any exceedance encountered will be handled locally between the state and local governments.

DEC's Division of Air Quality has a meteorologist on staff. The role of this employee is to provide meteorological support to the entire Air Quality Division as well as local air agencies and the public. This support includes all facets of meteorological data, data interpretation and analysis, and weather forecasting. The meteorologist also issues air advisories to the public based on air pollutant data, satellite imagery, and weather observations when an air quality episode is occurring or is expected to occur. The state, through its meteorologist, has access to all recorded weather information in real-time and through the archives at the National Centers for Environmental Information (NCEI).

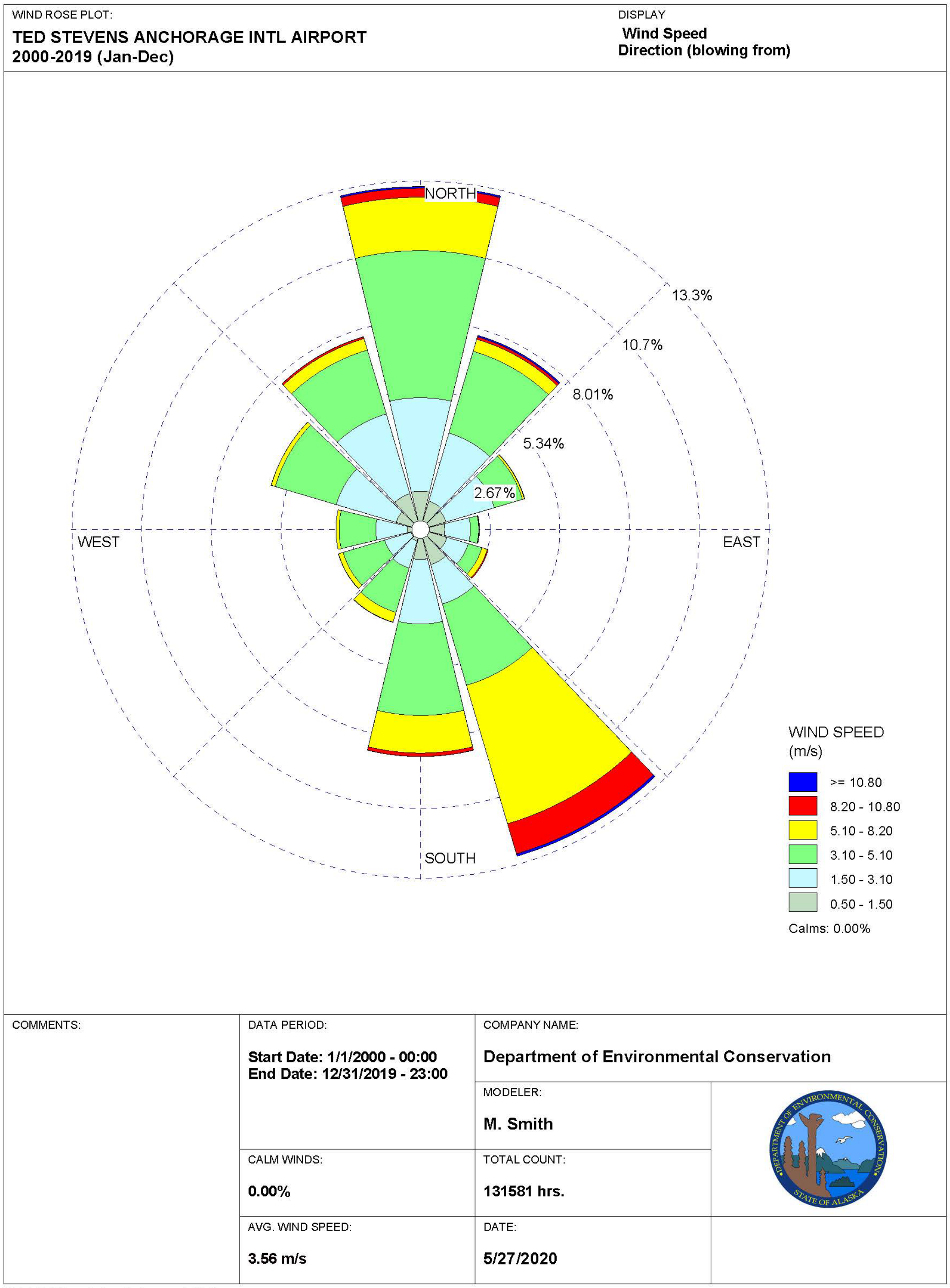


Figure 4. Windrose for the Ted Stevens Anchorage Intl. Airport (2000 – 2019)

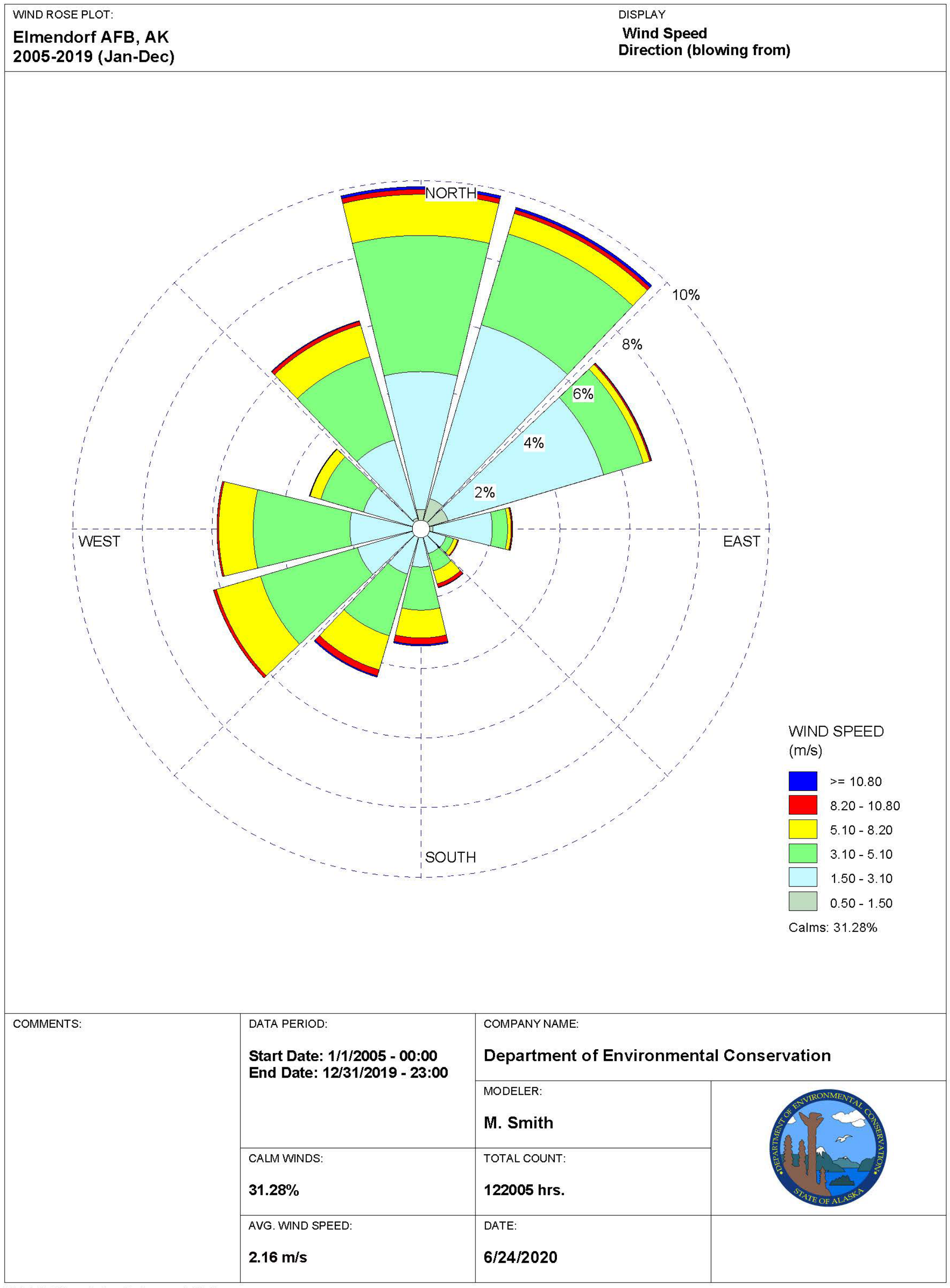
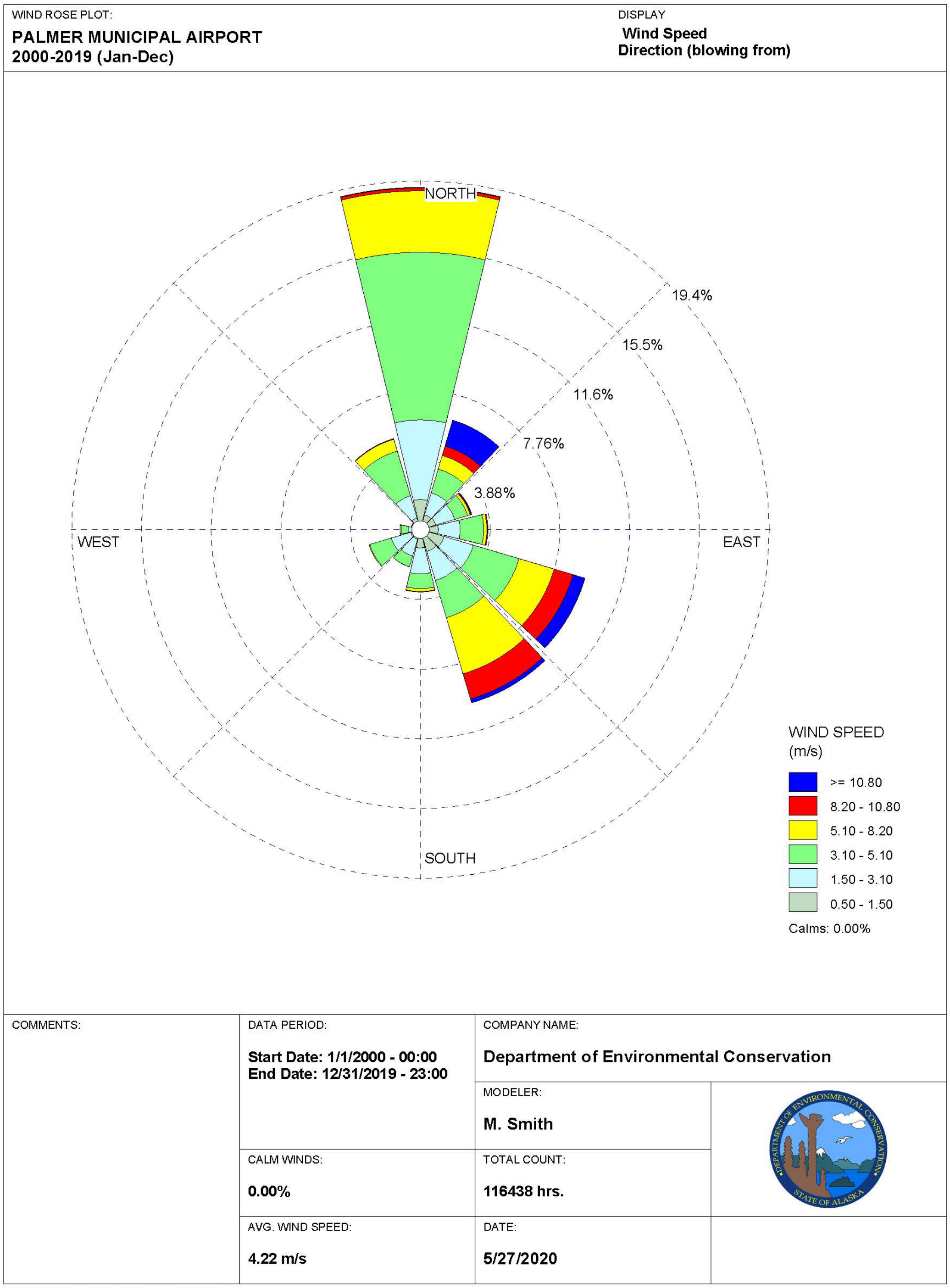


Figure 5. Windrose for Elmendorf AFB (2000 – 2019)

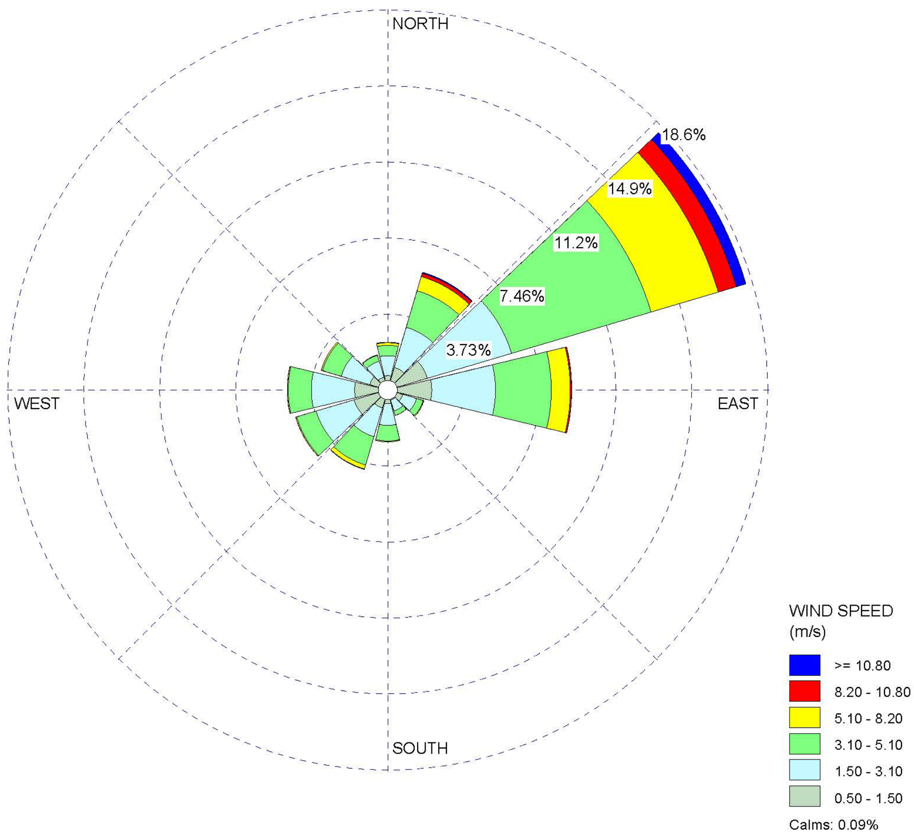


WRPLOT View - Lakes Environmental Software

Figure 6. Windrose for the Palmer Municipal Airport (2000 – 2019)

WIND ROSE PLOT:
WASILLA MUNICIPAL AIRPORT
2000-2019 (Jan-Dec)

DISPLAY
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2000 - 00:00 **End Date: 12/31/2019 - 23:00**	**Department of Environmental Conservation**	
		MODELER: **M. Smith**	
	CALM WINDS: **0.09%**	TOTAL COUNT: **90921 hrs.**	
	AVG. WIND SPEED: **3.20 m/s**	DATE: **5/28/2020**	

WRPLOT View - Lakes Environmental Software

Figure 7. Windrose for the Wasilla Municipal Airport (2000 – 2019)

6. DEC's Air Monitoring Strategy

Because of Alaska's size and its small population density of approximately1.2 residents per square mile, it is cost prohibitive to monitor in all areas of the state or even the majority of the well dispersed 331 Alaskan communities. Therefore, AMQA has taken a three-pronged approach to the monitoring network design:

- Monitoring in larger communities to cover the largest possible population exposure with a stable long term network of monitors
- Monitoring in designated smaller towns that are representative of multiple communities in a region. This monitoring is generally performed as shorter term studies in the range of several months to a few years.
- Monitoring in response to air quality complaints or emergencies. For this DEC Air Quality has had to rely on the public to help identify potential air quality issues and these studies are often conducted shorter term, using portable analyzers and samplers.

Air monitoring has historically focused on Alaska's largest population centers: the Municipality of Anchorage and Matanuska Susitna Borough, the Fairbanks North Star Borough, and the City and Borough of Juneau. This is also where the regulatory monitoring sites have been established. Due to stagnant or decreasing funding for air quality assessments over the past ten years the program had to reduce the monitoring to the required regulatory sites based on EPA requirement for CBSAs. Currently the only non-regulatory site in the State's network is the particulate matter site in Bethel, which is operated with in-kind local support.

Since the last network assessment in 2016, the network has seen an overall reduction in sites and resources. First the local governments of the Municipality of Anchorage and the Fairbanks North Star Borough returned monitoring obligations and operations back to the state due to their own budget constraints. Currently all air quality monitoring statewide, except for citizen science monitoring, regional haze (IMPROVE) monitoring, and industry monitoring for permit applications, is conducted by the State's AMQA program, consisting of 12 positions.

7. Alaska's Air Quality Monitoring Priorities

Alaska's ambient air quality issues focus on particulate matter. Almost every community in the state can be impacted by wildland fire smoke during the summer and road dust from gravel roads or other windblown dust.

While other pollutants are also emitted into the atmosphere, the combination of comparatively small population centers, small number of stationary sources, the location and density of industries, and the lack of sun light to cause pollutant formation, result in lower concerns for the other criteria pollutants.

While DEC is required to look at all NAAQS, the following pollutant monitoring efforts are the ones of most interest to Alaskans:

1. Fine particulate matter ($PM_{2.5}$) monitoring
2. Coarse particulate matter (PM_{10}) monitoring
3. Wildland fire monitoring ($PM_{2.5}$)
4. Carbon monoxide (CO) monitoring
5. Lead (Pb) monitoring
6. Ozone (O_3) monitoring

Table 4 summarizes the extent of these seven pollutants by listing communities violating the NAAQS.

Table 4. Communities violating the NAAQS

Priority	Pollutant	Communities violating NAAQS
1	$PM_{2.5}$	Fairbanks North Star Borough
2	PM_{10}	Several rural communities *
3	CO	none
4	Pb	none
5	Ozone	none
6	SO_2	none
7	NO_2	none

** Road dust monitoring data for rural Alaska is limited. Results of existing monitoring suggest that the majority of rural villages have a summer and early fall road dust problem*

The current network consists of nine sites with 26 monitors. There are three sites each in the Fairbanks North Star Borough and the Municipality of Anchorage, and one site each in the Mat-Su Borough, the City and Borough of Juneau and the community of Bethel.

Fine Particulate Matter - $PM_{2.5}$

Combustion processes are the primary sources of fine particulates in the atmosphere. Health research has found that $PM_{2.5}$ size particles are creating a major health problem in communities across the United States. Numerous studies not only identify respiratory impacts, but also a high rate of cardiovascular diseases associated with particles which penetrate deep into the lungs. For people in Alaska, this problem is exacerbated by increased exposure to fine particulate during extended wintertime temperature inversions with extreme cold temperatures, and wildland fires during the summer months.

Fine particulates have been a concern in some Interior Alaska communities, especially during the winter months when extremely strong inversions trap emitted particles close to the surface. In the smaller, outlying villages, this problem is normally associated with wood smoke. In the large communities, like in the Fairbanks North Star Borough, the pollution mix is comprised of wood smoke from home heating, emissions from oil based home heating, automobiles, power generation, and other local combustion sources.

Coarse Particulates - PM_{10}

PM_{10} or 'dust' impacts most people living and visiting the State of Alaska and has been a pollutant of concern for over 40 years. Monitoring for dust in the major communities of Anchorage, Juneau, the Mat-Su Valley, and Fairbanks has been going on for over twenty years. As a result, two locations in the State were designated nonattainment for dust in 1991: the Municipality of Anchorage (Eagle River) and Mendenhall Valley in the City and Borough of Juneau (CBJ or Juneau).

Eagle River, a community of about 30,000 located 10 miles northeast of downtown Anchorage, was designated as a nonattainment area for airborne particulate (PM_{10}) in 1987. This designation was the result of air quality violations recorded between 1985 and 1987 when the community was largely "rural" and had many unpaved roads. In addition, the TSP monitor was located on the top of a one story building extension adjacent to a highly trafficked gravel road. The Municipality of Anchorage developed a PM_{10} control plan which focused on paving or surfacing the communities gravel roads. This strategy was very effective (all local roads were paved or treated with recycled asphalt) and no violations have been measured since October 1987. After EPA decided not to adopt a proposed regulation provision that would have automatically reclassified areas like Eagle River with long periods of compliance with the standard from non-attainment to maintenance areas, the Municipality of Anchorage developed a "Limited Maintenance Plan" (LMP) for Eagle River.[1] This was submitted to EPA for approval in September 2010. EPA approved the LMP on January 7, 2013.[2]

Juneau's Mendenhall Valley was designated nonattainment for PM_{10} on November 15, 1990. The two primary sources of PM_{10} required the community to develop two primary control measures to minimize exceedance of the standard. The first was to issue alert notices for people to curtail use of their woodstoves to reduce the impact from wood smoke and the second was to pave or treat roads to minimize the impact of fugitive dust. The CBJ and the DEC submitted a request to re-designate Juneau as a limited maintenance area with the US EPA in February, 2009[3]. EPA approved the re-designation on May 9, 2013.

---

[1] The proposed regulation would have eliminated the need to prepare a maintenance plan. Normally the submission of a maintenance plan to EPA is required before reclassification can be considered.
[2] 2013 Eagle River Limited Maintenance Plan http://dec.alaska.gov/air/anpms/SIP/anchIM_ERLMP_QAPP_Oct2010.htm
[3] 2009 City and Borough of Juneau Limited Maintenance Plan http://www.dec.state.ak.us/AIR/anpms/doc-anpms/CBJ_PM10_LMP_20FEB09.pdf

Road dust has also been identified as a problem in most of the rural communities in Alaska. With the exception of the "hub" communities, most of the smaller villages have a limited road system and little resources to pave roads. In addition, the soil composition is often frost susceptible and not conducive to paving. With the use of all-terrain vehicles (4 wheelers) and automobiles, the amount of re-entrained dust has increased substantially. On a dry summer day, dust levels can easily reach into the mid 300 $\mu g/m^3$ range with maximum concentrations easily exceeding 500 $\mu g/m^3$. To address the rural dust problem, which was identified during a several year joint-monitoring effort among DEC, village environmental staff, and the State Department of Transportation (DOT), DOT secured funding from the State Legislature for a dust control program. That demonstration project started in summer 2010 with eight rural villages and was spearheaded by DOT in conjunction with researchers at University of Alaska Fairbanks (UAF) and DEC. Each village was given the option of using various palliatives or water to control the dust during the summer months and a sprayer for product/water application that would be adaptable for use on the back of a truck or pulled behind an ATV. DEC continues to work with EPA, Alaska DOT, the University of Alaska Fairbanks (UAF) and tribal communities to find suitable palliatives and improve techniques and technologies for their application. UAF has increased outreach and education about proper road maintenance. In recent years DEC has also increased emphasis on road dust prevention by encouraging communities to work on public education and local speed control on unpaved roads.

Carbon Monoxide-CO

Alaska's two largest communities, Anchorage and Fairbanks, were designated non-attainment for carbon monoxide (CO) in the mid to late 1980s. Motor vehicle CO emissions increase in the cold winter temperatures experienced in Alaska. These elevated emissions combined with strong wintertime temperature inversions resulted in both communities exceeding the CO standards numerous times each winter. Anchorage and Fairbanks were both initially designated as *Moderate Nonattainment* for CO and, later in 1996, re-designated as *Serious Nonattainment* after failing to reach attainment in the allotted time frame. Despite implementation of effective vehicle inspection and maintenance programs and other local air quality control strategies, neither community would have been able to reach attainment without the significant improvements in automobile emission controls that have been mandated by EPA in new vehicles over the past three decades. Neither community has had a violation of the CO standard since 1999. Both communities requested re-designation to attainment and were reclassified as Limited Maintenance Areas in 2004. EPA approved the second ten year LMP for Fairbanks on February 22, 2013[4] and for Anchorage on July 13, 2011[5] with amendments from March 3, 2014.

Lead Monitoring-Pb

To meet source-oriented lead monitoring requirements and after consultation with EPA, DEC decided to pursue a modeling demonstration to show that lead concentrations at the ambient boundary of the Red Dog Mine meet EPA's 2008 lead standard. On August 11, 2016, EPA approved

[4] 2013 Fairbanks North Star Borough CO Limited Maintenance Plan, http://dec.alaska.gov/air/anpms/SIP/SIPDocs/ANCH_FNSB_CO_LMP/Fbks_CO_LMP.pdf

[5] 2013 Anchorage Limited Maintenance Plan, http://dec.alaska.gov/air/anpms/SIP/SIPDocs/Anchorage%20CO%20Maintenance%20Plan%20Combined%20July%2022%2014.pdf

the State of Alaska's waiver request for lead monitoring at the Red Dog Mine based on the results of dispersion modeling. The results of the modeling showed that the maximum ambient air 3-month rolling average lead concentration at the mine boundary did not exceed 50 percent of the lead NAAQS. Pursuant to 40 CFR Part 58 Appendix D, section 4.5(a)(ii), this waiver must be renewed every 5 years as part of the Alaska 5-year Air Monitoring Network Assessment. A copy of the EPA approval letter can be found at https://dec.alaska.gov/media/10608/red-dog-mine-lead-monitoring-waiver-letter-epa-081116.pdf. Teck Alaska Inc. the operator of the Red Dog Mine, submitted an updated modeling analysis in 2020, demonstrating again that the facility does not contribute to lead concentrations in ambient air in excess of 50% of the lead standard. DEC recently reviewed and approved the analysis and report and submitted the new waiver request to EPA on June 12, 2020.

Ozone Monitoring-O_3

The March 27, 2008 revision of the national ozone standard required the State of Alaska to establish an O_3 monitoring program by April 1, 2010. The regulation required at least one SLAMS O_3 site in a CBSA with a population greater than 350,000. The Anchorage/Mat-Su Valley population forms the only combined Metropolitan Statistical Area (MSA) in the State of Alaska which meets the criteria. Ozone monitoring was performed in Anchorage, Wasilla and Palmer. The concentrations measured in Anchorage and the Mat-Su Valley are consistently lower than the National Park Service Denali site (considered a clean background site), indicating that Southcentral Alaska does not experience net ozone production but rather ozone scavenging below the natural background levels. To focus sparse resources on pollutants of interest, DEC requested a monitoring waiver for ozone in the Anchorage MSA. EPA granted a five (5) year waiver on October 15, 2018.

Sulfur Dioxide Monitoring-SO_2

No sulfur dioxide monitoring, other than that conducted at the Fairbanks NCore site, is currently being performed in Alaska. With the 2010 revision of the SO_2 standard and introduction of the 1 hour standard additional monitoring in rural communities might be warranted. Short term studies in St Mary's indicated a potential for exceedances of the SO_2 standard during the winter time. Especially in light of the ubiquity of diesel power generation in rural Alaska, elevated SO_2 levels may exist, but have not been assessed. As staffing and funding allows, DEC will conduct studies in rural communities to better understand the issue.

Nitrogen Oxide Monitoring-NO_2

DEC currently does not monitor for NO_2. None of the emission sources, industrial as well as residential, emit sufficient NO_2 to require monitoring. Even with the 2010 revision to the NO_2 standard and introduction of the 1 hour NO_2 standard, DEC does not expect to see any elevated ambient levels.

8. Alaska's Air Quality Summary

The following section summarizes data and trends for each of the criteria pollutants monitored in the Alaska Air Monitoring Network in order of pollutants of concern, (i.e $PM_{2.5}$, PM_{10}, CO, O_3, SO_2, NO_2)[6]. The monitoring network currently includes long-term sites in the urbanized areas of Anchorage, Fairbanks, Juneau, and the Matanuska-Susitna Valley (Mat-Su). A rural monitoring site was established in Bethel in May of 2018.

Fine Particulate Matter ($PM_{2.5}$)

24-hour $PM_{2.5}$ Concentrations

Fine particulate matter ($PM_{2.5}$) is the main pollutant of concern in Alaska. $PM_{2.5}$ particles are largely the result of combustion processes e.g., home heating, wildfires, automobile exhaust, etc. A network of monitors was installed statewide in 1999 following the promulgation of the fine particulate matter standard in 1997. Alaska monitoring network sites have recorded an increase in concentrations in excess of the $PM_{2.5}$ NAAQS, especially after December 2006, when the 24-hour $PM_{2.5}$ standard was strengthened from 65 $\mu g/m^3$ to 35 $\mu g/m^3$.

A large area in the FNSB was designated nonattainment for the 24-hour $PM_{2.5}$ standard in December 2009. The Hurst Road site (formerly name the North Pole Fire Station #3 site) is currently one of the highest reading $PM_{2.5}$ site in the nation, although concentrations have decreased steadily over the last few years. The high concentrations measured at this site determine the design value for the entire nonattainment area. In 2019, the long term State Office Building site was shut down with the NCore site continuing to monitor the downtown Fairbanks area while a new maximum impact site in Fairbanks (A Street) was established.

The rural monitoring site in Bethel does not collect regulatory $PM_{2.5}$ data, it uses a BAM configured in a way that does not meet Federal Equivalent Method (FEM) requirements. The site is meant to address public concerns by surveying and initially assessing $PM_{2.5}$ impacts in the community.

The following charts and tables summarize $PM_{2.5}$ data from monitoring sites operated by DEC throughout the state. These data exclude measurements of exceptional events. Additional site details are contained in the 2020 Network Plan[7].

[6] No lead monitoring is being conducted in the state. Source oriented monitoring was waived for Red Dog mine. A second waiver request has been submitted to EPA for approval.
[7] http://dec.alaska.gov/air/air-monitoring/monitoring-plans/

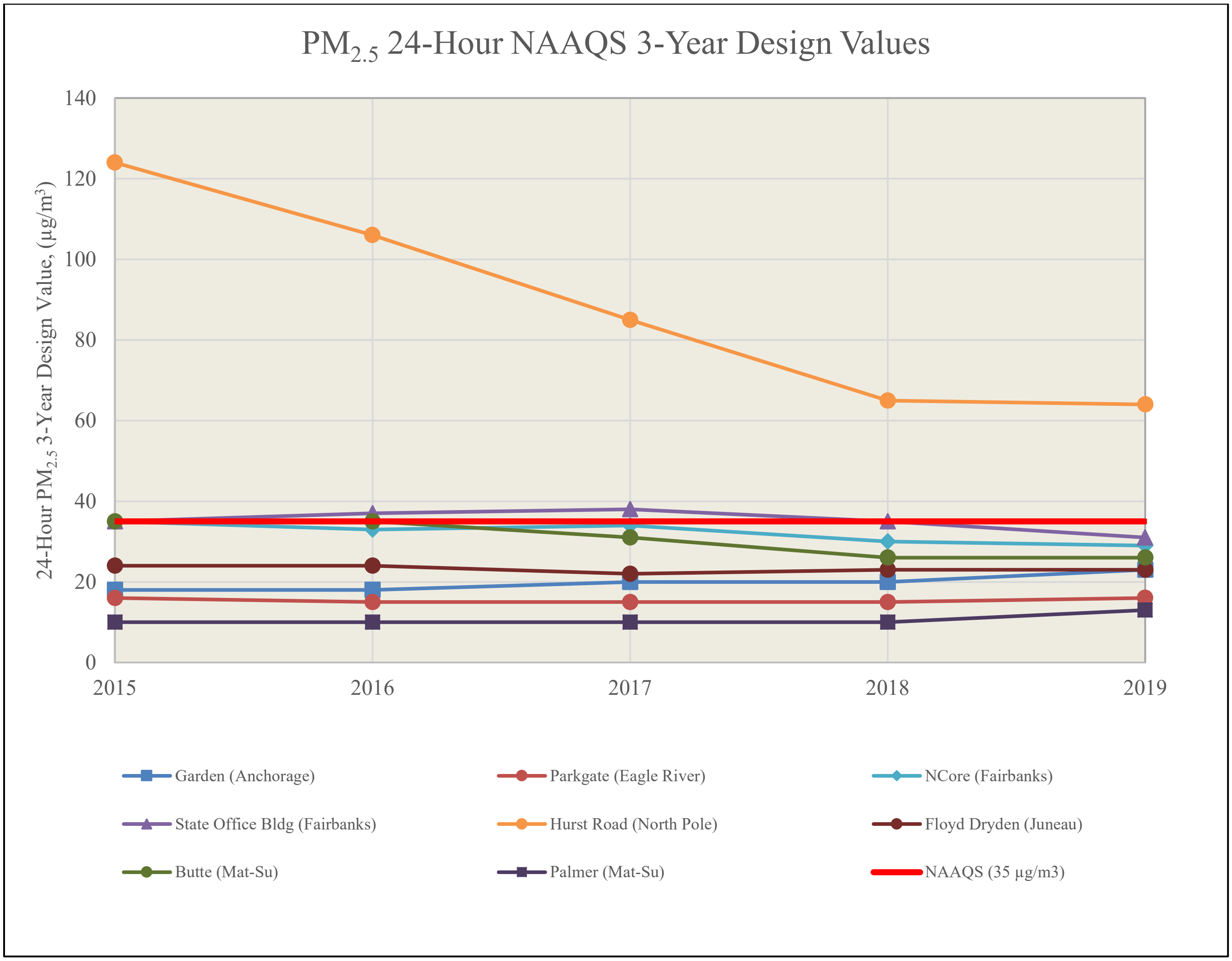


Figure 8. 24-hour $PM_{2.5}$ 3-year Design Values (2015-2019)

Table 5. $PM_{2.5}$ 24-hour NAAQS 3-year design values (annual 98th percentiles in parentheses), µg/m³

Monitoring Site	AQS ID	2015	2016	2017	2018	2019
Garden (Anchorage)	02-020-0018	18 (18.4)	18 (16.1)	20 (26.9)	20 (17.7)	23 (24.6)
Parkgate (Eagle River)	02-020-1004	16 (17.2)	15 (13.8)	15 (15.4)	15 (14.4)	16 (18.5)
Bethel (Bethel), (non-FEM)	02-050-0001				N/A (8.5)	N/A (9.9)
State Office Bldg (Fairbanks)	02-090-0010	35 (35.3)	37 (39.7)	38 (38.0)	35 (27.0)	31 (27.7)
NCore (Fairbanks)	02-090-0034	35 (36.7)	33 (30.3)	34 (34.4)	30 (25.3)	29 (27.7)
Hurst Road (North Pole)	02-090-0035	124 (111.6)	106 (66.8)	85 (75.5)	65 (52.8)	64 (65.0)
A Street (Fairbanks)	02-090-0040					N/A (34.1)
Floyd Dryden (Juneau)	02-110-0004	24 (21.0)	24 (24.0)	22 (22.4)	23 (22.1)	23 (24.9)
Butte (Mat-Su)	02-170-0008	35 (37.9)	35 (29.2)	31 (26.2)	26 (19.2)	26 (27.7)
Palmer (Mat-Su)	02-170-0012	10 (9.9)	10 (9.2)	10 (11.1)	10 (8.5)	13 (18.7)

In addition to wintertime pollution, summertime wildland fire smoke creates $PM_{2.5}$ pollution statewide most years. While most of these fires are not controllable and the state is not penalized for the pollution, wildland fire smoke poses a significant public health threat. DEC issues air quality advisories statewide during periods when wildland fire smoke impacts air quality.

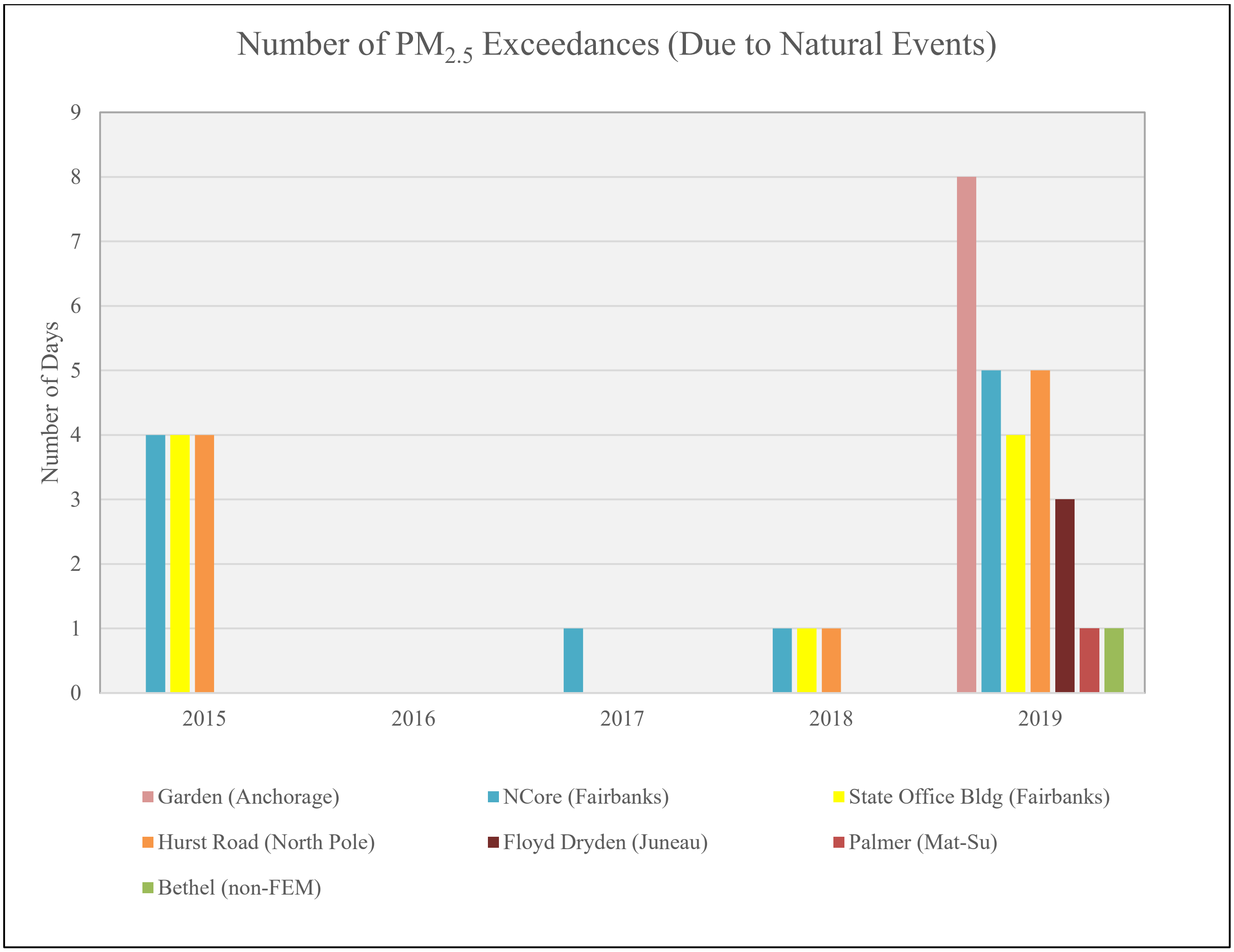


Figure 9. 24-hour $PM_{2.5}$ exceedance days due to natural events

Annual $PM_{2.5}$ Trends

The annual $PM_{2.5}$ 3-year design values across the state since have been relatively stable (Figure 8). North Pole and Fairbanks have the highest annual average design values while the other parts of the state are generally below 7 µg/m^3. Several annual design values shown do not meet completeness criteria due to the availability of data as sites are installed or removed, they are represented by hollow points and dashed lines in the chart and asterisks in the table.

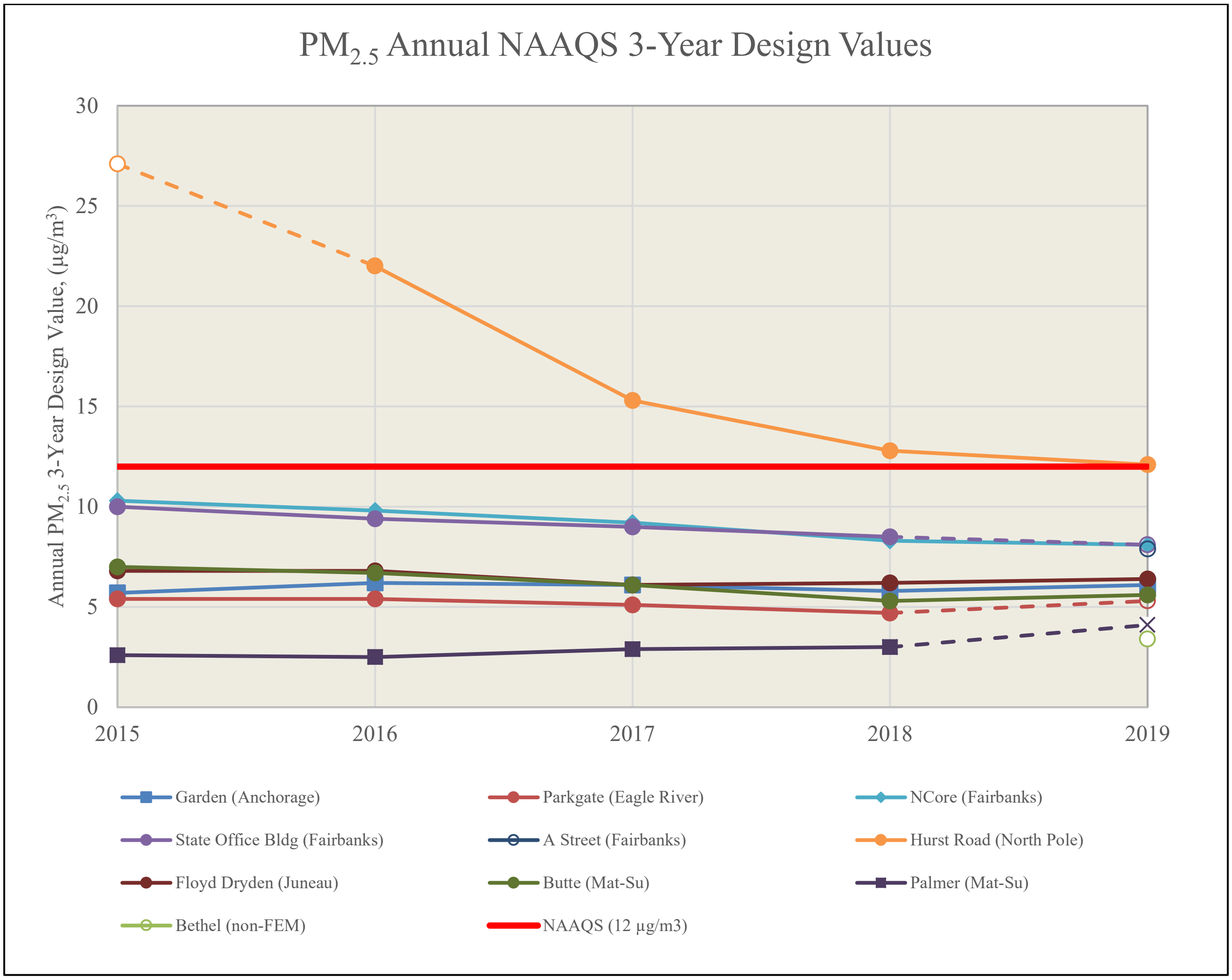


Figure 10. $PM_{2.5}$ annual average 3-year design values (2015-2019)

Table 6. $PM_{2.5}$ Annual NAAQS 3-year design values (weighted annual means in parentheses), µg/m^3

Monitoring Site	AQS ID	2015	2016	2017	2018	2019
Garden (Anchorage)	02-020-0018	5.7 (6.3)	6.2 (6.5)	6.1 (5.5)	5.8 (5.4)	6.1 (7.3)
Parkgate (Eagle River)	02-020-1004	5.4 (6.1)	5.4 (4.8)	5.1 (4.2)	4.7 (5.1)	5.3* (6.4)
Bethel (Bethel), (non-FEM)	02-050-0001					3.4* (3.4)
State Office Bldg (Fairbanks)	02-090-0010	10 (9.1)	9.4 (8.8)	9.0 (9.1)	8.5 (7.6)	8.1* (7.6)
NCore (Fairbanks)	02-090-0034	10.3 (9.9)	9.8 (9.1)	9.2 (8.6)	8.3 (7.3)	8.1 (8.4)
Hurst Road (North Pole)	02-090-0035	27.1* (18.4)	22 (13.7)	15.3 (13.9)	12.8 (10.9)	12.1 (11.4)
A Street (Fairbanks)	02-090-0040					7.9* (7.9)
Floyd Dryden (Juneau)	02-110-0004	6.8 (6.6)	6.8 (6.0)	6.1 (5.6)	6.2 (6.9)	6.4 (6.8)
Butte (Mat-Su)	02-170-0008	7.0 (6.8)	6.7 (5.8)	6.1 (5.7)	5.3 (4.6)	5.6 (6.5)
Palmer (Mat-Su)	02-170-0012	2.6 (2.7)	2.5 (2.8)	2.9 (3.2)	3.0 (3.0)	4.1* (6.3)

* Annual Design Values do not meet completeness criteria

Coarse Particulate Matter (PM_{10})

Although DEC's monitoring focus has shifted to $PM_{2.5}$, Alaska has remained aware of PM_{10} impacts due to natural events as well as human-caused road dust in rural villages and spring road sweeping in the Muncipality ofAnchorage. Exposed glacial river beds combined with gap winds through mountain passes cause several natural PM_{10} exceedances each year on average. In 2015, the Fairbanks NCore site had such high $PM_{2.5}$ levels due to extreme wildfires in Interior Alaska that three days also were recorded as PM_{10} exceedances.

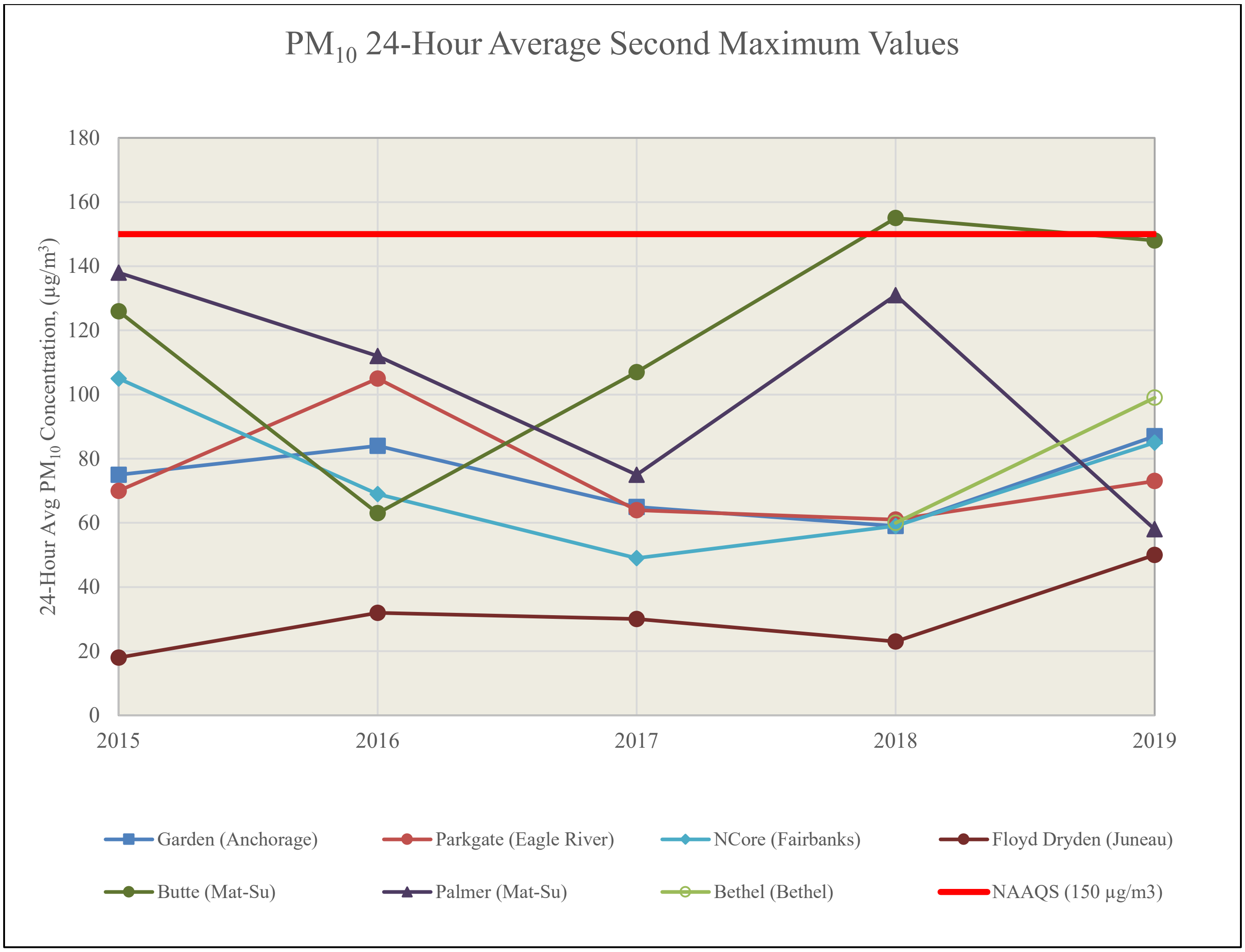


Figure 11. PM_{10} 24-hour average 2nd maximum values (2015-2019)

Tables 7 summarizes PM_{10} data from monitoring sites around the state. These data exclude measurements of exceptional events. Additional site details are contained in the 2020 Annual Network Plan (http://dec.alaska.gov/air/air-monitoring/).

Table 7. PM_{10} 1st/2nd Maximum 24-hour Average concentrations, µg/m³

Monitoring Site	AQS ID	2015	2016	2017	2018	2019
Garden (Anchorage)	02-020-0018	78 / 75	88 / 84	68 / 65	59 / 59	88 / 87
Laurel (Anchorage)	02-020-0045	91 / 76	134 / 115	100 / 88	128 / 102	105 / 98
Parkgate (Eagle River)	02-020-1004	90 / 70	110 / 105	68 / 64	62 / 61	79 / 73
Bethel (Bethel)	02-050-0001				108 / 60	124 / 99
NCore (Fairbanks)	02-090-0034	124 / 105	80 / 69	60 / 49	72 / 59	124 / 85
Floyd Dryden (Juneau)	02-110-0004	21 / 18	34 / 32	30 / 30	24 / 23	64 / 50
Butte (Mat-Su)	02-170-0008	147 / 126	187 / 63	114 / 107	187 / 155	186 / 148
Palmer (Mat-Su)	02-170-0012	143 / 138	210 / 112	77 / 75	255 / 131	90 / 58

CO Summary

Alaska's two largest communities, the Municipality of Anchorage and the FNSB, were reclassified as *Limited Maintenance Plan* areas for CO in 2004 and updated, second 10 year *Limited Maintenance Plans* were submitted in 2014. CO has been measured in the Municipality of Anchorage and the FNSB since 1972. Since 2002, there have been no exceedances of the 8-hour (9 ppm) or 1-hour (35 ppm) CO NAAQS in either community.

Table 8. CO 1st/2nd Maximum 8-hour Average concentrations, ppm

Monitoring Site	AQS ID	2015	2016	2017	2018	2019
Garden (Anchorage)	02-020-0018	2.8 / 2.8	3.6 / 3.0	3.7 / 3.5	2.9 / 2.7	2.6 / 2.4
NCore (Fairbanks)	02-090-0034	3.8 / 2.4	2.1 / 2.0	2.3 / 2.0	2.0 / 2.0	2.4 / 2.1

O_3 Summary

DEC currently monitors O_3 at the NCore site in the FNSB. DEC had previously operated an O_3 monitor at the Palmer site in the Matanuska-Susitna Valley, which was shut down in 2019. General trends were consistent among years and sites. The monthly average of the maximum houly ozone concentrations per day are highest in April and May and lowest in December and January. DEC discontinued O_3 monitoring at the Palmer site in 2018 after obtaining a 5-year O_3 monitoring waiver from EPA[8]. Ozone values are consistently below the 8-hour NAAQS of 0.070 ppm (Table 9).

Table 9. O_3 8-Hour NAAQS 3-year design values (4th maximum values in parentheses), ppm

Monitoring Site	AQS ID	2015	2016	2017	2018	2019
NCore (Fairbanks)	02-090-0034	0.045 (0.045)	0.041 (0.036)	0.043 (0.048)	0.041 (0.041)	0.045 (0.047)
Palmer (Mat-Su)	02-170-0012	(0.047)	(0.044)	0.044 (0.043)	0.043 (0.044)	

[8] http://dec.alaska.gov/air/air-monitoring/monitoring-plans/

SO_2 Summary

DEC currently monitors SO_2 at the NCore site in the FNSB. Trends are consistent among years with highest concentrations measured in December and lowest concentrations measured in September. All 1-hour concentrations measured fall well below the NAAQS of 75 ppb (Table 10). The annual 99th percentile has never exceeded 50% of the NAAQS.

Table 10. SO_2 1-Hour NAAQS 3-year design values (annual 99th percentile values in parentheses), ppb

Monitoring Site	AQS ID	2015	2016	2017	2018	2019
NCore (Fairbanks)	02-090-0034	37 (34)	36 (35)	35 (35)	36 (37)	34 (30)

NO_2 Summary

DEC monitored NO_2 at the NCore site in the FNSB between July 1, 2014 and October 1, 2019. All daily 1-hour maximum concentrations measured were below the standard of 100 ppb. The highest concentrations were recorded in January and lowest concentrations are in July. The monitor was shut down for budgetary reasons. The 98th percentiles were all well below the 1-hour NO_2 NAAQS.

Table 11. NO_2 1-Hour NAAQS 3-year design values (annual 98th percentile values in parentheses), ppb

Monitoring Site	AQS ID	2015	2016	2017	2018	2019
NCore (Fairbanks)	02-090-0034	N/A* (68.1)	N/A* (54.9)	59 (55.2)	55 (53.8)	N/A** (53.2)

*Design values are calculated as the average of data from three full calendar years

**No design value was calculated due to incomplete data for the third year.

9. Alaska's Air Quality Monitoring Network Technology Results & Discussion

Technology

Particulate Matter

As sampling equipment has aged and reached the end of its service life over the past several years, DEC was able to secure funding to replace many of the samplers needed to keep the network operating smoothly. Rather than direct replacement of the equipment, changes to the network required some shifting of resources and equipment types to meet our monitoring objectives and ensure adequate data capture. For continuity and for lack of proven alternatives, monitoring stations have continued to feature semi-continuous Met One BAM 1020 monitors for PM_{10} and $PM_{2.5}$. These operate as Federal Equivalent Method (FEM) monitors in areas other than the Fairbanks North Star Borough (FNSB) nonattainment area, where Very Sharp Cut Cyclones (VSCC) have been replaced by Sharp Cut Cyclones (SCC). This change was made in consultation with EPA Region 10, due to the failure of the BAM 1020 to consistently meet Class III FEM performance criteria.

Due to limitations of the EPA Air Quality System (AQS), DEC removed the majority of Thermo Scientific (Thermo) 2000i Federal Reference Method (FRM) samplers from the network. They were replaced as the primary samplers in the Fairbanks nonattainment area, by Thermo Scientific 2025i Sequential FRM samplers. Thermo 2000 and 2000i samplers were removed from Juneau's Mendenhall Valley Floyd Dryden site, with BAM 1020 analyzers as the primary samplers for $PM_{2.5}$ and PM_{10}. Thermo Scientific 2000i samplers were also installed at the Mat-Su Valley Butte site for $PM_{2.5}$ and at the Eagle River Parkgate site for PM_{10} collocation.

A detailed analysis and discussion is provided in the 2020 Annual Network Plan, (http://dec.alaska.gov/air/am/2020_Air_Monitoring_plan.pdf). The state will continue to employ FRM monitors as the primary samplers at any site where the Class III FEM criteria are not met consistently. Table 12 summarizes the particulate matter sampling technology used at the long term SLAMS and SPM sites.

The NCore site houses a Met-One Super SASS Speciation Monitor and the URG 3000N Carbon Sampler, and in the summer of 2019 SASS & URG samplers were also installed at the Hurst Road site.

Calibration and auditing equipment

For calibrating low flow PM equipment, both FRM and continuous, DEC uses the Mesa Labs deltaCal (formerly BGI) and Alicat FP-25BT reference devices, which are annually re-certified. The state's air quality auditor maintains separate equipment for the sole purpose of independent quality control checks. The Met One Super SASS speciation sampler is calibrated and audited with either an FP-25BT or deltaCal. The URG 3000N is calibrated by either an FP-25BT or Mesa Labs tetraCal.

Gaseous Analyzer Equipment

The NCore site has a trace level Thermo Scientific 48i CO analyzer, which will be replaced by a Teledyne T300U in the summer of 2020. The Anchorage CO site at Garden operates a Thermo Scientific 48i analyzer. A Teledyne 400E ozone analyzer is used in Fairbanks (NCore) and will be replaced by a Thermo Scientific 49iQ in the summer of 2020. Table 13 shows a detailed list of the remaining gaseous analyzers and sites.

Calibration and auditing equipment

The Fairbanks NCore site employs an Environics 9100 transfer standard to perform routine precision checks, calibrations, and verifications of the gaseous instruments. The 9100 will be replaced in the summer of 2020 by a Teledyne T700U, which will perform the same functions.

Fairbanks NCore and the Anchorage Garden site each derive zero air for dilution of EPA Protocol gas cylinders, and zero verification and calibration, from Teledyne T701H Zero Air Generators. The DEC QA officer maintains a dedicated zero air generator, transfer standard, and calibration gases for his audits.

Equipment replacement strategy

There are currently eight $PM_{2.5}$ and PM_{10} FRM samplers in operation in the network, 4 each of the Thermo 2000i and 2025i series. The oldest 2000i's have been in service for approximately 5 years, the newest, 3 years. We anticipate several more years before they require replacement. Three of the 2025i samplers are less than 3 years old, with one that is 1 year old. While most PM samplers have been replaced in the last several years, DEC also has three BAM 1020 instruments (Floyd Dryden, Butte, and A-Street) that have reached the end of their service life and require replacement. DEC has received deferred maintenance funding that may cover replacement of those instruments in late 2020.

All NCore gaseous analyzers, transfer standard, zero air generator, and primary ozone standard are slated for replacement in the summer of 2020. The instruments have been purchased and await testing and installation. The SO_2 and ozone analyzers are Thermo Scientific, with the remainder Teledyne.

DEC has identified two other gaseous analyzer needs, an SO_2 analyzer for the Hurst site to aide in the study of arctic sulfate formation, and the Garden site CO analyzer, which will be reaching the end of its service life within two years. These two instruments will cost approximately $30,000 and funding for the replacement will come from a federal grant to DEC in 2021 and 2022.

The gravimetric lab in Fairbanks uses a Mettler Toledo balance in a Measurement Technology Laboratories (MTL) AH500 climate controlled Automated Filter Weighing System (FWS) enclosure for all 47mm $PM_{2.5}$ and PM_{10} Teflon FRM filters. The lab also uses an MTL Laboratory Information Management System (LIMS), which was supplied with the FWS in 2019. DEC intends to restart a gravimetric filter lab in Juneau after lab renovations are complete. The balances are annually recertified and according to the auditor are in excellent condition. The Fairbanks lab XPR6UD balance is about 4 years old and early in its service life. The Juneau balance is a Sartorius SE2 that DEC obtained from the Fairbanks North Star

Borough and is expected to have at least 10 years of service life remaining. Periodic updates of the LIMS system are likely and anticipated in the budget.

Table 12. PM Equipment inventory – June 2020

#	Parameter	Equipment	Manufacturer	Location	Comments
4	PM 2.5	Partisol 2025i	Thermo Scientific	NCore, A-Street, Hurst (2)	Collocate at Hurst
3	PM 2.5	Partisol 2000i	Thermo Scientific	NCore, Butte, Parkgate	NCore part of coarse pair
1	PM 10	Partisol 2000i	Thermo Scientific	NCore	
7	PM 2.5	BAM 1020	Met One	NCore, A-Street, Hurst, Floyd Dryden, Garden, Butte, Bethel	
2	PM 2.5	Super SASS	Met One	NCore, Hurst	
2	PM 2.5	3000N	URG	NCore, Hurst	
7	PM 10	BAM 1020	Met One	NCore, Floyd Dryden, Garden, Butte, Parkgate, Laurel, Bethel	
Not in Operation					
2	PM2.5	BAM 1020	Met One	Anchorage, Fairbanks	
2	PM 10	BAM 1020	Met One	Anchorage, Fairbanks	

Table 13. Gaseous Equipment inventory – June 2020

#	Parameter	Equipment	Manufacturer	Location	Comments
			Gaseous		
1	CO	T300 U	Teledyne	NCore	*Install Summer 2020
2	CO	Thermo 48i	Thermo Scientific	Garden, Spare	
1	SO_2	Thermo 43iQ-TL	Thermo Scientific	NCore	*Install Summer 2020
1	SO_2	Thermo 43i-TL	Thermo Scientific	Hurst	
1	NOx	Thermo 42i-TLE	Thermo Scientific		Spare - Fairbanks
1	NOy	T501y	Teledyne	NCore	*Install Summer 2020
1	NOy	Thermo 42i-Y	Thermo Scientific	NCore	
1	O_3	49iQ	Thermo Scientific	NCore	*Install Summer 2020
2	O_3	Teledyne 403E	Teledyne Model		Spare - Fairbanks
1	Relative Humidity	083E	Met One	NCore	
7	Ambient Temperature	083E	Met One	NCore, A-Street, Hurst	
3	Wind Speed/Direction	Windbird + Vane Anemometer	R. M. Young	Butte, Garden, Floyd Dryden	
9	Wind Speed/Direction	Sonic Anemometer 86004	R.M. Young	NCore, A-Street, Hurst, Spare	*Install Summer 2020
4	Wind Speed/Direction	Sonic Anemometer 50.5H	Met One	Spare	

Data Acquisition and Storage

To manage the large datasets that are produced by continuous analyzers, a centralized data logger system and database are necessary. DEC has contracted with DR DAS, the US distributor of the Envitech Suite of data acquisition software and uses the Envidas suite of software on servers at each long term site around the state (See Figure 15.) The site servers report data back to a state-owned server, which houses the database. The data acquisition system (DAS) consists of a central database that collects semi-continuous and continuous data from DEC's monitoring sites, an Air Resource Manager (Envista ARM) that allows for Quality Assurance/Quality Control (QA/QC) of the data, and a program that translates validated data to XML format for submittal to EPA's AQS database. The data acquisition system allows for remote access of site servers which record measurements and run some QC checks automatically. Email, phone or text alarms are automatically triggered and automatically sent when the system detects malfunctions or errors that have been specified during the setup of the site logger. Error and diagnostic checks on gaseous monitors can also be performed remotely and automation results in reduced travel time to the sites that are away from the DEC offices. The Met One BAM, however still requires onsite programming should an error be recorded by the data acquisition system. DEC is conducting the bulk of its data processing, manipulation, and analysis within the DR DAS system. Particulate FRM data are handled separately, since some of the QC requirements are not accommodated in the DR DAS set-up.

The Envista DAS sends the data to two real-time websites: EPA's AirNow website (https://www.airnow.gov/) and DEC's real-time website (http://dec.alaska.gov/Applications/Air/airtoolsweb/Aq). DEC designed and developed its own Air Quality Index website. It displays the AQI color codes and levels for all sites and all pollutants connected to the database on one page. The public can access 72-hour time series graphs and site information, like location and site photos. The website features a query function, which allows individuals to download preliminary, raw data.

DEC created its own data warehouse, which regularly copies the DR DAS database and also houses data and metadata from projects that are not connected to the DR DAS database.

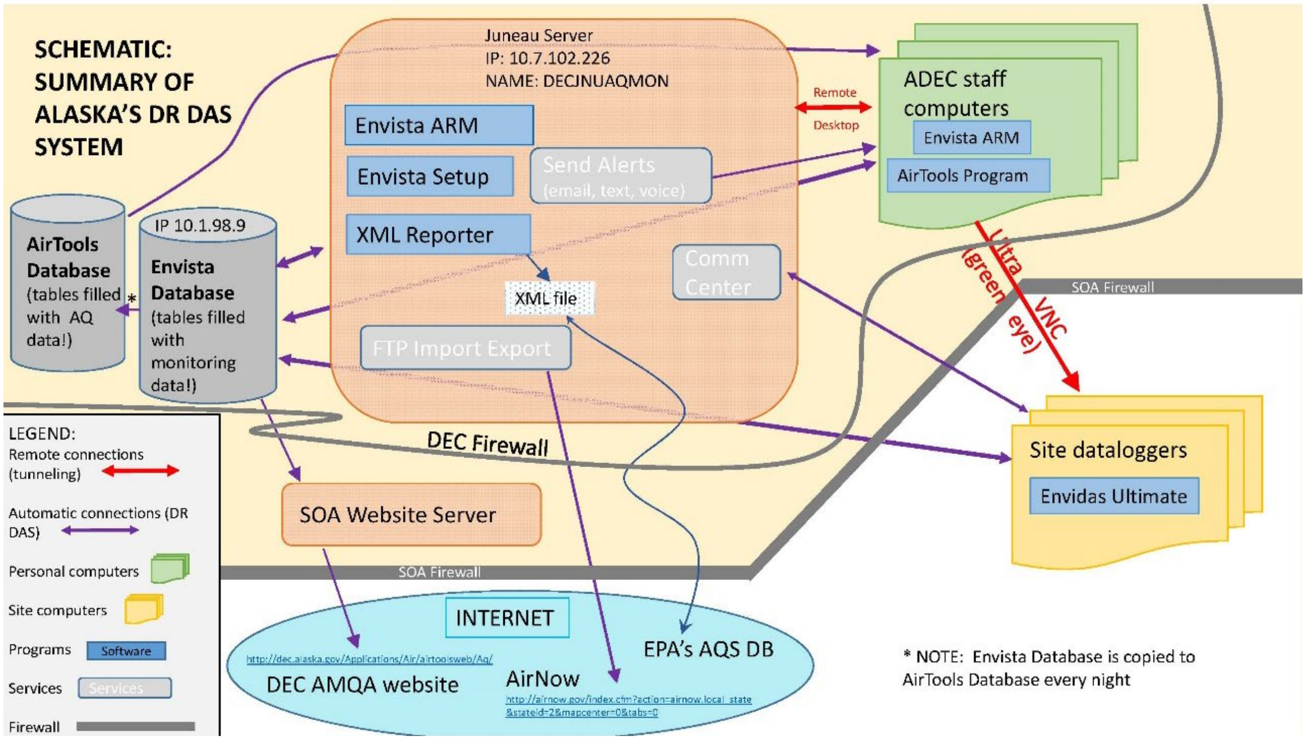


Figure 12. Schematic of Alaska's DAS

10. Network Evaluation

A network assessment includes a re-evaluation of the objectives and budget for air monitoring, the evaluation of a network's effectiveness and efficiency relative to its objectives and costs, and the development of recommendations for network reconfigurations and improvements. The sections below provide a brief assessment of the current network and anticipated improvements planned or strived for in coming years.

Monitoring Objectives and Budget

Most of the DEC's air monitoring activities are focused around population centers and areas that have shown in the past to have air quality problems. The Alaska Department of Labor and Workforce Development projects the highest growth rate within the state to occur in the Mat-Su Borough (40% increase between 2015 and 2045). The Mat-Su Borough population has been consistently growing over the past several decades. That was the reason DEC enlarged its monitoring network to three monitoring sites in this area in 2010. However, due to budget cuts and reduced staffing, DEC consolidated some of its operations by decommissioning the Wasilla site in March 2015. The Wasilla site had recorded low values for PM_{10} and $PM_{2.5}$. The Palmer site ($PM_{2.5}$, PM_{10}) was shut down in 2019. It also recorded low values for $PM_{2.5}$, but was used to issue advisories for windblown dust (PM_{10}), which happen periodically in the area. Currently the only site remaining in the Mat-Su Borough is the Butte site ($PM_{2.5}$, PM_{10}). The current statewide ambient monitoring network now consists only of the required regulatory sites with the exception of the Bethel Special Purpose Monitoring (SPM) site.

Alaska's Air Monitoring and Quality Assurance Program has a staff of twelve full time positions to cover a large state. In 2016 the Fairbanks North Star Borough handed back all regulatory monitoring responsibilities and duties to DEC. At the same time the Municipality of Anchorage announced that as of January 1, 2017 all monitoring tasks would revert back to the State. As of 2017, DEC is responsible for site operations, data review and analysis, and data submission and reporting for all regulatory ambient monitoring sites in Alaska.

DEC continues to look for efficiencies wherever possible. The network consists of a combination of Federal Reference Method (FRM) and Federal Equivalent Method (FEM) monitoring technologies. Wherever instrument performance and data quality allow it, DEC has implemented a shift to automated and real time data collection.

The Department received a waiver from EPA of the requirement to monitor for ozone in the Anchorage MSA through 2023. It is likely that DEC will request an extension of the waiver. The area is not expected to see net ozone generation based on the limited emissions of ozone precursors and the sub-arctic latitude that results in a lack of required photochemistry to produce ozone. The cost and effort of ozone monitoring in the Anchorage MSA is not supported by the tight Division budget, especially considering the low probability of measuring values near the health based standard.

New FEM technology (i.e. automated technologies) as well as the use of a data acquisition system have reduced some of the burden on staff resources. However, the increasing number of parameters, data, and meta data collected by the analyzers along with the required quality assurance and control (QA/QC) shift the focus from site operations to data display, reduction and reporting. The ever expanding federal QA/QC requirements translate into additional work for site operators and data analysts, both in terms of sampler maintenance to provide for the required high performance, as well as the post collection data review, validation and documentation. Additionally, the desire both by the public and EPA to have access to real time quality data online in a clear and intuitive presentation, poses challenges that significantly impact a small program.

The comparatively level funding from EPA conflicts with the greatly increased workload resulting from online data reporting and analysis, the move from 24 hour averages for PM monitoring to hourly averages, and required gaseous pollutant monitoring. Federally required exceptional event documentation and waiver requests in a state where summer wildland fires and spring time windblown dust events are regular events, rather than the exception, put an additional strain on a program already stretched thin.

The program was able to secure state funds to replace some of the aging equipment. Most gaseous analyzers have been or will be replaced in 2020. Funding for regular instrument upkeep and replacement is a constant concern. The average lifespan before instruments either become technologically obsolete or require extensive maintenance and replacement parts is about seven years. Since most of the analyzers were purchased at the time the NCore site was established in 2011, most if not all analyzers are on the same replacement schedule. This means that in regular intervals DEC is require to find the roughly $150,000 to update equipment at the site. Replacement of a whole fleet of analyzers at one time puts a burden on the program that is already suffering under a tight budget. To avoid data loss due to malfunction, DEC is anticipating the next instrumentation replacement sometime in 2027.

At this point DEC does not foresee the expansion of the existing regulatory network of long term sites. Due to current budget and staffing constraints, DEC has limited ability to conduct special purpose monitoring. Cost and logistics for these short term projects require close coordination with the local tribal and city governments. DEC regularly receives requests to monitor in small communities throughout the state and needs to strike a balance of investigating community complaints with the need to spread monitoring sites into areas not previously assessed.

Network Effectiveness and Efficiency

While the monitoring network meets the regulatory requirement in terms of number of monitoring stations and monitored pollutants, it is confined to the population centers and does not adequately describe conditions in outlying and rural communities.

Operation of the regulatory monitoring network is stable and meets all the federal requirements. DEC continues to focus on maintaining the core monitoring site operations and reporting data to the federal air quality database, AQS. DEC has to prioritize these activities while providing more extensive data analysis, reduction and reporting for public consumption. Any additional special studies, special projects, wide spread monitoring in smaller communities or emergency monitoring for wildfires or volcanic eruptions are fit in as staff time and funding allow.

The large landmass and minimal infrastructure of Alaska pose unique challenges for monitoring that impact the costs of what would be considered routine monitoring activities elsewhere. While site operators are usually responsible for multiple sites, Alaska's sites can be many hundreds of miles apart. This means that these sites either have to be managed remotely or that frequent travel is required. Travel to outlying communities or even just beyond the core network is very expensive. Often trips require overnight stays to allow sufficient time to complete tasks associated with setting up new monitoring equipment and training or to troubleshoot malfunctioning equipment. While in recent years, DEC has not been able to expand monitoring into rural communities, staff have focused on cooperation with other state and federal agencies and local governments to leverage resources.

New sensor technology has developed rapidly in recent years. These technology are seeing increased private use and DEC continually receives public requests for using and comparing these technologies to data collected at the regulatory monitoring sites. DEC will need to create more opportunity for staff to research and keep up with these emerging technologies, like low cost sensors, and to test their limitations in our harsh climate. As a seasonal particulate matter monitoring network statewide is needed for natural events wildland fire smoke, opportunities lie with new portable, lower cost sensor technology.

There is a need for reliable PM_{10} portable sensor technology. Currently most PM sensors are designed to measure $PM_{2.5}$ and smaller particles. While they still display PM_{10} concentrations, they use a scaling algorithm that estimates PM_{10} concentrations based on the $PM_{2.5}$ size fraction. Field studies have documented that most of these sensors do not have a satisfactory performance when it comes to PM_{10}. Therefore, in Alaska where these two particulate matter categories have very distinct sources, this technology is not yet appropriate for measuring road dust.

Recommendations for Network Reconfigurations and Improvements

Based on the overall low number of industrial sources in the state and the low levels of manmade ambient pollution, DEC does not plan to expand the regulatory monitoring network. Regulatory monitoring stations are expensive and labor intensive.

New sensor technology with lower costs, less stringent quality assurance/quality control requirements, smaller foot print and ease of operations has the promise to fill in some of the data gaps in smaller communities. There is a need to expand particulate matter monitoring into underserved areas of the state that are areas impacted by frequent wildland fire smoke, seasonal or year round road dust and winter time inversions.

Throughout the State there are only a few communities with populations between 1,000 and 10,000. These communities are often hub communities, i.e. regional transportation hubs that are served by larger commercial airlines and are jumping off points to the smaller communities by smaller commercial airlines or private transport. Approximately one third of Alaska's population lives in small rural communities of less than 1,000 residents.

Community Based Monitoring

As funding becomes available, DEC plans to expand sensor pod technology into the hub communities to begin collecting baseline information across the state. These sensor pods can be customized according to the interest and concern in the community. All sensor pods would have a basic set of sensors that include particulate matter, SO_2, NO_2 and CO sensors. Where funding allows, meteorological sensors and volatile organic carbon (VOC) sensor might be added. DEC will start working with our federal and tribal partners to establish and expand this network.

Several schools across the state have voiced an interest in participating in the school flag program (https://www.airnow.gov/air-quality-flag-program/). So far, the lack of routine daily statewide air quality forecasting for Alaska has made participating in the flag program difficult.

Smaller and cheaper sensor technology will be used to expand particulate matter monitoring for wildfire smoke strategically into smaller communities. This effort, started in 2019, was spearheaded by the University of Alaska Fairbanks, when approximately 30 PurpleAir sensors were set-up in rural areas all around the state. Due to the short lifespan of these low cost sensors (EPA estimates a life time of 1-3 years) keeping the sensor network functional and updated will be an ongoing commitment and could prove challenging.

As mentioned above, road dust is a major concern statewide. DEC will continue to follow low cost sensor development and investigate and test low cost sensor technology suitable for PM_{10} monitoring.

Source specific monitoring

Cruise Ship Air Impacts

DEC is in the process of establishing a sensor network in Southeast Alaskan port communities. In 2019 DEC conducted a pilot study in downtown Juneau in response to rising public complaints regarding air emissions from cruise ships. The study did not find that impacts from cruise ship emissions to fine particulate matter concentration rise to the level of concern, but that further investigation of gaseous pollutant impacts might be warranted. DEC was able to purchase a number of sensor pod samplers with the ability to measure SO_2, NO_2 and CO in addition to particulate matter and some meteorological parameters on an hourly basis. The equipment will initially be tested in Juneau with the intent to expand the network into the major cruise ship port communities in Southeast Alaska and further into Southcentral Alaska.

Wildland fire Smoke

As predictions for more frequent and severe fire seasons increase, a stable and long term seasonal or year round monitoring network is needed to better inform the affected public and aid in smoke forecasting. If DEC is successful at establishing a community based low cost sensor network, it might serve to meet the need for a wildland fire smoke network.

Air Toxics program

This monitoring assessment does not address air toxics since Alaska does not have an Air Toxics Program anymore. It was shut down in the early 2000s due to budget cuts. Since then some short term studies have been undertaken in various areas, and a number of air toxic pollutants remain of concern. Monitoring data from the Municipality of Anchorage show that ambient concentrations of volatile organic compounds such as toluene, ethyl benzene, xylenes and 1,3-butadiene and some polycyclic aromatic hydrocarbons (PAHs) are very high compared to other communities in the U.S.[9] Any future air toxics monitoring in the state would require federal funding.

The Fairbanks North Star Borough has been in nonattainment for $PM_{2.5}$ since 2009. The main component in $PM_{2.5}$ in this area is organic carbon and wood heat is believed to be the dominant source. Wood smoke contains many toxic component, but DEC has no information about air toxics levels in the community and the area would be a prime location for a National Air Toxics Trend site (NATTS).

Another area that has consistently requested some air toxic sampling is the North Slope Borough. As oil and gas development expands to areas closer to communities, the public concern about volatile organic compounds (VOCs) and other air toxics increases.

The establishment of even one air toxics sampling site, will require both capital and operational funds. The implementation of an air toxics program in a major community is estimated to would cost upwards of $500,000.

Radiation Monitoring

There are three radiation monitoring network sites (RadNet) in Alaska, located in Anchorage, Fairbanks and Juneau. The site in Anchorage is operated by the Alaska Department of Health and Social Services, and the DEC Air Monitoring and Quality Assurance Program operates the sites in Fairbanks and Juneau. Shortly after the 2011 Fukushima Dai-Ichi Nuclear Power Plant incident additional short term monitoring was set up in Nome, Unalaska/Dutch Harbor and Juneau. At the time the question was brought up whether the existing sites are intended as early warning stations or rather to document radiation levels experienced throughout the state. If early warning is the goal, the sites in Anchorage and Fairbanks are not the best locations to meet this objective. The sites should either be moved to the coast to allow for early detection and actions before the radiation reaches the population centers inland or additional coastal monitors should be installed to meet this need. Discussion is ongoing and no decision has been reached yet on changes to this network.

Other considerations

Over the years, monitoring activities that are not specifically targeting a monitoring site have been delayed or deferred. Dedicated funding and staff expertise is required for some of these activities, like building a wireless communication device or a specialized air sensor pod. The lack of stable fast internet connections or even wide spread stable cell phone infrastructure makes data telemetry either very expensive when using off-the-shelf systems that require satellite transmission and often do not work well in Alaska's isolated communities. Sensor pods that work in more moderate climatic conditions, might not be suitable for Alaskan wintertime

[9] The Municipality of Anchorage has prepared a report, *Assessment of the Effectiveness of New Mobile Source Air Toxics Regulations in Reducing Ambient Concentrations of Benzene and Other Air Toxics in Anchorage, Alaska*, December 2010, that summarizes the results of a one-year monitoring study conducted between October 2008 and October 2009. Air toxics data collected in this study are compared and contrasted with data from other communities in the U.S.

conditions, with temperatures dropping to -50F. Adaptations to our harsh climate are usually not available on a commercial scale and in-house development might be the best path forward. Developing Alaskan proof technology in-house is time consuming and requires the right skill set.

Widespread data dissemination capabilities is another necessity that has been delayed for a while. DEC is working on developing an application for disseminating air quality information and advisories via text messages and emails statewide. Currently DEC has a contract with a media company to distribute the air alerts generated during elevated pollutant levels within the FNSB nonattainment area during winter times only.

Summary

Air Monitoring is expensive, but even more so in Alaska, as a result of unique challenges including the state's extreme climate, varied ecosystems, large size, limited road system, decentralized power grid, and limited and unstable phone and internet infrastructure. Due to these factors, air monitoring related travel and site maintenance costs are likely among the highest in the nation per capita served. In the past, Alaska's situation was partially compensated through special consideration of these higher expenses in the federal funding allocations. In recent years federal and state funding has stagnated, resulting in actual decrease of available funding over time due to increased personnel cost and inflation.

Despite DEC and EPA efforts, Alaska remains well behind the rest of the country in both the spatial coverage of its monitoring network and technical advancements for sampling automation and web-based data reporting. While DEC continuously strives to improve our monitoring capacity, current staffing and funding levels have not been supportive of the goal of narrowing the technological and data gap between the State and the nation.

During the next five years, we anticipate an increased public demand for real time data access via the internet, not just in Alaska's growing communities like the Mat-Su Borough, or problem areas like the Fairbanks North Star Borough, but also from rural and tribal communities, which face many of the same issues as the metropolitan areas do. Public awareness of the effects of poor or compromised air quality is growing throughout the state.

To be responsive to public requests, DEC will need to look to low cost sensors to expand monitoring in previously underserved areas. This might initially be spearheaded with low levels of funding and interagency cooperation. To build a stable statewide network, dedicated funding and staffing will be necessary. The fast growing sector of new and cheaper monitoring technology that supports a 'citizen scientist' movement will require states to spend time communicating challenges of the new technology as performance is still an issue for a lot of this low cost technology.

Other data needs like an air toxics program in Anchorage and Fairbanks will require an extensive effort and funding. At this point with state budgets in recession, a new program like this would likely need to rely entirely on federal funding.

11. References Cited

Alaska Department of Environmental Conservation, 2010, "Eagle River PM_{10} Limited Maintenance Plan."

Alaska Department of Environmental Conservation, 2009, "Juneau's Mendenhall Valley Proposed PM_{10} Limited Maintenance Plan."

Alaska Department of Labor & Workforce Development (14 January 2016). Press Release. Retrieved from http://labor.alaska.gov/news/2016/news16-01.pdf

Alaska Department of Labor & Workforce Development. Alaska Population Projections 2015 to 2045 (April 2016). Retrieved from http://live.laborstats.alaska.gov/pop/projections/pub/popproj.pdf

Athey, J.E, L.K. Freeman, L.A. Harbo, and P.S. Lasley, "Alaska's Mineral Industry 2013: Special Report 69," (Alaska) Department of Natural Resources and (Alaska) Department of Commerce, Community, and Economic Development

The Economic Value of Alaska's Seafood Industry, McDowell Group (14 July 2016). Retrieved from http://ebooks.alaskaseafood.org/ASMI_Seafood_Impacts_Dec2015/pubData/source/ASMI%20Alaska%20Seafood%20Impacts%20Final%20Dec2015%20-%20low%20res.pdf

Fairbanks North Star Borough, 2013, "Fairbanks Limited CO Maintenance Plan: A plan addressing the second 10 years of the 2004-2024 CO maintenance planning period."

Mineral Production, State of Alaska Department of Commerce, Community & Economic Development (14 July 2016). Retrieved from https://www.commerce.alaska.gov/web/ded/DEV/MineralsDevelopment/MineralsProduction.aspx

Municipality of Anchorage, Department of Health and Human Services, 2011, "Anchorage CO Maintenance Plan: Technical revision to the State of Alaska Air Quality Control Plan."

State of Alaska, Economy, Alaska Kids' Corner (n.d.). Retrieved from http://alaska.gov/kids/learn/economy.htm