*Report developed by a STAR Grant participant with the San Luis Obispo – South, California (Nipomo Mesa area) community*

# Interpreting Nipomo Mesa Air Quality Data (February 2020)

## Introduction

One of the many reasons people relocate to California's Central Coast is the region's excellent air quality – which is considered some of the best in the Nation. However, those of us who move to the Nipomo Mesa area in San Luis Obispo County are surprised and dismayed to discover that the normally healthy air here is punctuated with periods when air quality becomes some of the worst in the Nation. When prevailing Northwest winds are from just the right direction, and the windspeed is just high enough, very fine particulate dust blows off the Oceano Dunes creating unhealthy conditions for several hours at a time.

The County Air Pollution Control District (APCD) provides Nipomo Mesa residents with effective tools to help us understand, monitor and forecast local air quality conditions. Some residents also purchase their own low-cost home air quality monitors. These household monitors utilize a very different technology than the EPA approved instruments used by APCD. The air quality readings of these different types of monitors often differ, and this creates confusion among Mesa residents.

The confusion was amplified in 2018 when another type of monitor was introduced as part of an evaluation and testing program conducted by South Coast Air Quality Management District. The PurpleAir, LLC monitors being tested performed very well in worldwide testing, but performed very poorly under the unique conditions found at times on Nipomo Mesa. Basically, PurpleAir monitors were nearly blind to Oceano Dunes particulates when it was present.

During periods of poor air quality, Mesa residents had official APCD readings telling them that conditions were unhealthy, while PurpleAir monitors were telling them that air quality is good.

This three-part essay, "Interpreting Nipomo Mesa Air Quality Data" has been prepared to help residents to do three things: (1) understand the relative strengths and limitations of the various air quality monitor readings; (2) anticipate the unique wind direction and speed data that gives rise our unhealthy conditions; and (3) protect their homes when these unhealthy conditions arise.

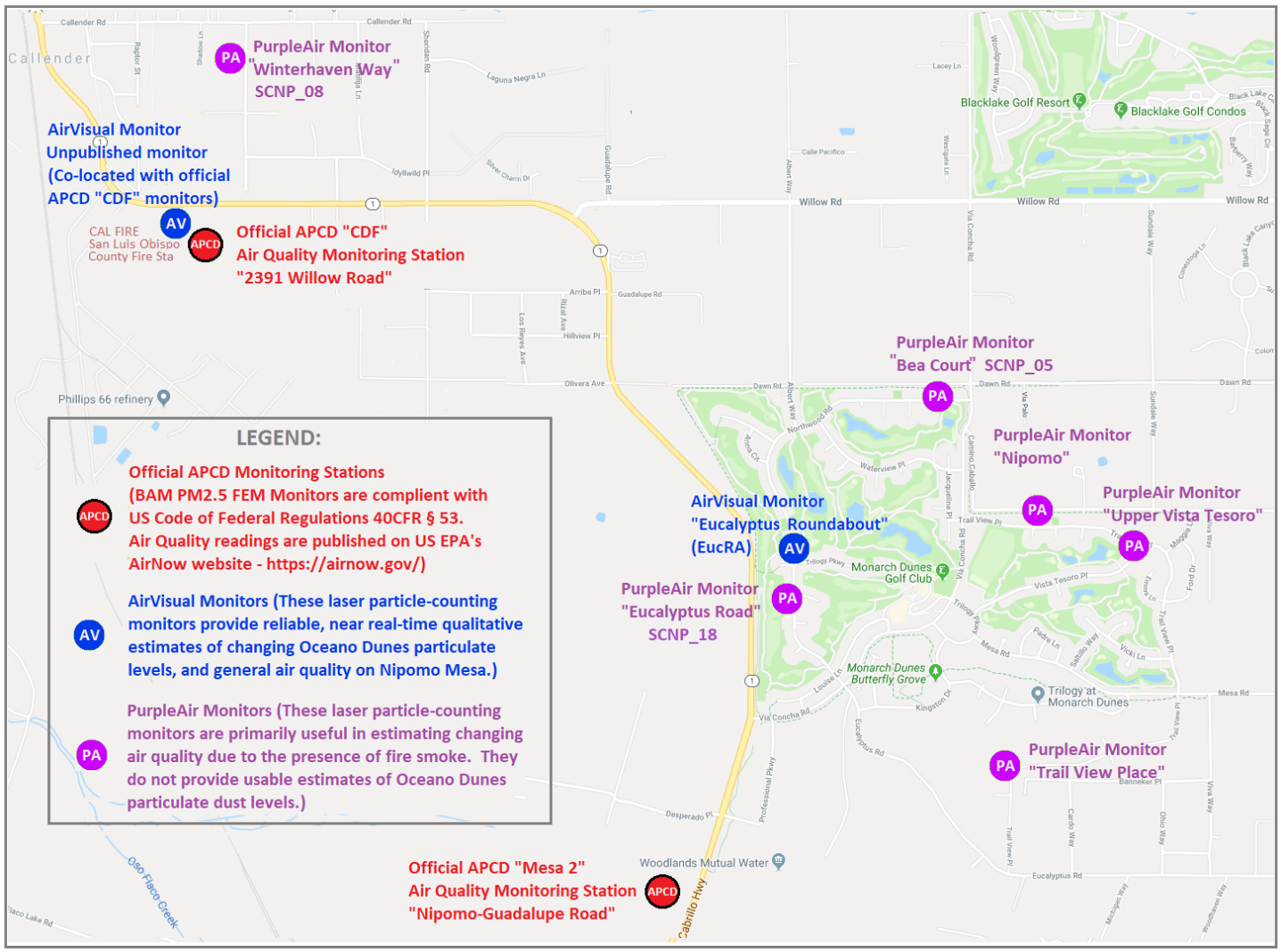
# Part 1: Monitoring Mesa Air Quality

It's easy to get confused with different air quality readings provided by a variety of monitors on Nipomo Mesa. What is most useful to Mesa residents is real-time information on what's happening with air quality at any given moment. Let's break this seemingly complicated issue into bite-sized chunks and pull it together with a simple conclusion. Part 1 explains how to use the available monitors to get information we want. Part 2 will discuss air quality forecasting on the Mesa, and how to identify projected wind conditions that can create particulate dust events. Finally, Part 3 will cover how we can apply this information to protect our indoor door air quality at home.

**1. Federally Certified Monitors:** There are two official SLO County Air Pollution Control District (APCD) monitoring stations that track air quality on the Western Mesa. These locations, locally called '**CDF**' and '**Mesa 2**' are shown as red 'APCD' symbols on the map (below). The instrumentation at these stations provides an historical record of actual particulate pollution levels, as required by the EPA and federal regulation. However, the instruments aren't capable of providing *real-time* information. Data is reported to the public an hour or longer after-the-fact. Why? These federally certified instruments – called Beta Attenuation Monitors (BAM) – work by collecting airborne particles for 50-minutes, then analyzing and weighing them in the remaining 10-minutes of each hour. This hourly data takes time to collect, process and publish on EPA's '**AirNow**' website, the SLOC APCD website, and also several worldwide air quality reporting sites. When we see the BAM air quality data, we can be confident that it's *quantitatively* accurate – but *qualitatively*, it's hour-old news. When conditions are rapidly changing, as they can on Nipomo Mesa, we can't be confident that the data reflects current conditions.

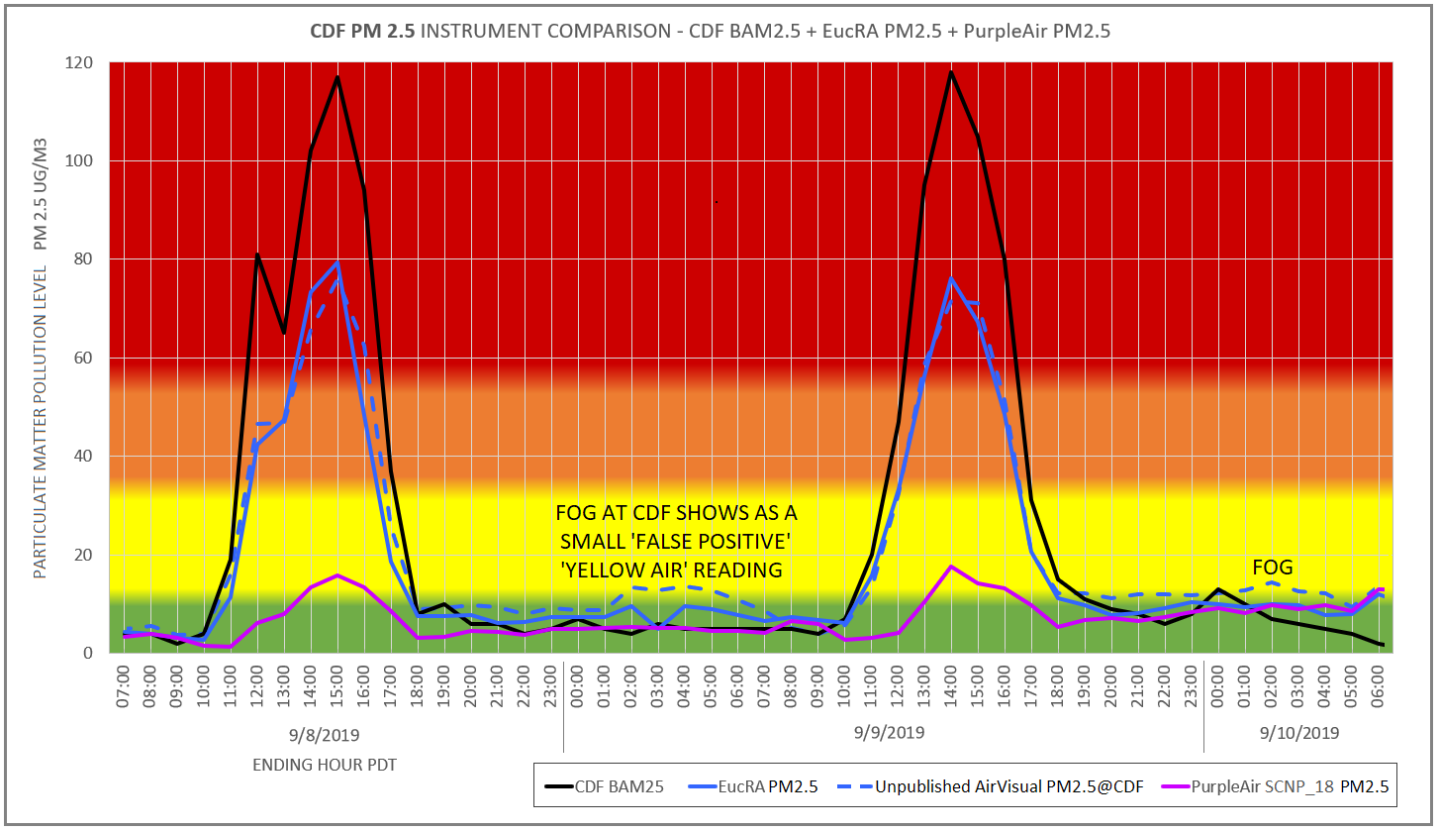
**2. AirVisual Laser Air Quality Monitors:** During the last year, APCD has been investigating better ways to publish more timely alerts when air quality is rapidly deteriorating. As part of this effort, two AirVisual monitors were deployed on the Mesa in 2018 (shown as blue 'AV' symbols on the map). One is installed adjacent to the official BAM monitors at APCD's CDF site at the CAL FIRE Station on Route 1. The other is located two miles downwind of CDF near the Eucalyptus-Northwood traffic circle. Both these AirVisual monitors sample and report estimated air quality every five minutes. A year and a half of data collection has shown that the AirVisual monitors and APCD's BAM monitors are almost perfectly time synchronized – as can be seen on the line graph (below).

The AirVisuals may be qualitatively near perfect for real-time reporting, but they're quantitatively imperfect. For example - you can see from the graph that the AirVisual monitors read Oceano Dunes dust peaks as only 65-75% of actual levels measured by official BAM instruments. On the other hand, when SLO County had smoke pollution from Northern California wildland fires late last year, the AirVisuals recorded peaks 200% of the BAM's. So, AirVisuals may be able to tell us almost immediately that air quality is changing, and in which direction, but they only provide rough estimates of actual Dunes dust pollution levels.




**3. PurpleAir Laser Air Quality Monitors:** Most of the PurpleAir air quality monitors on the Mesa were installed as part of a citizen science project sponsored by South Coast Air Quality Management District (AQMD) in the LA basin. PurpleAir monitors (purple 'PA' symbols on the map) are in the same crowded, competing group of low-cost laser particle-counting sensors. They can provide useful estimates of air quality in environments to which they're individually best suited. Unlike the AirVisual monitors, which are relatively good at estimating Oceano Dunes dust particulate levels, PurpleAir monitors perform very poorly here, as seen on the

graph. However, PurpleAir has been shown to be better at correctly estimating particulate pollution from wildland fire smoke, and have been successfully deployed in North County.




**4. Air Quality Forecasts:** APCD issues a daily air quality forecast. You can find it on APCD's website (slocleanair.org), in the Tribune daily weather report, or subscribe to it by email. You can also subscribe to '**AirAware**' mobile text alerts for blowing dust or smoke. AirAware mobile alerts are the fastest way to receive air quality information from official BAM monitors.

*[Update]* A new AirAware text notification option that APCD recently launched is '**Early Alert**'. Early Alerts apply a computational algorithm to the most recent air quality readings in order to predict high dust levels on the Mesa. They are texted automatically to subscribers one hour ahead of predicted dust events giving time to take precautionary health protective measures.

Overall, APCD daily air quality forecasts are usually accurate. However, the Nipomo Mesa presents a thorny forecasting problem. That's because blowing dust events are highly susceptible to small changes in wind direction. There is a very narrow band between West-Northwest and Northwest that these events can occur. The events are also highly sensitive to wind speed. A change of just a few degrees on the compass, or a few miles-per-hour can cause the dust plume to appear, disappear, or shift one way or another within a few minutes.

**5. Conclusions:** We already have the tools we need to follow air quality on Nipomo Mesa before, during and after dust events. Official BAM monitors at APCD's CDF and Mesa 2 stations can report very accurate pollution levels – but only after-the-fact; while AirVisuals can provide near real-time information when air quality is rapidly deteriorating or improving – but only estimate of actual pollution levels. AirAware Early Alert texts can predict possible next-hour air quality impacts. Watching these together, with an understanding of their different strengths and limitations, can allow us make better informed lifestyle choices.

**6. Accessing AirAware Text Alerts and AirVisual Notifications:** Subscribe to APCD AirAware mobile text alerts, and select the types of notifications you wish to receive (i.e. early alert, blowing dust, smoke impacts): https://www.slocleanair.org/air-quality-alerts.php

The AirVisual monitor located near the Eucalyptus-Northwood traffic circle is the only "public" AirVisual site currently reporting on the Mesa. It is identified as '**Eucalyptus Roundabout**' (or '**EucRA**' for short). The online data stream from this monitor has been updating air quality conditions at the site every five minutes, 24/7 for over a year. To access this near real-time information on your smartphone using the AirVisual app, use the EucRA "Share Code": homepage > places tab > three-dot menu > "follow monitor" > **woezmtax**. You can also set the app to provide visual or audible notifications when Mesa air quality is rapidly declining. (For step-by-step directions, see the Appendix.)

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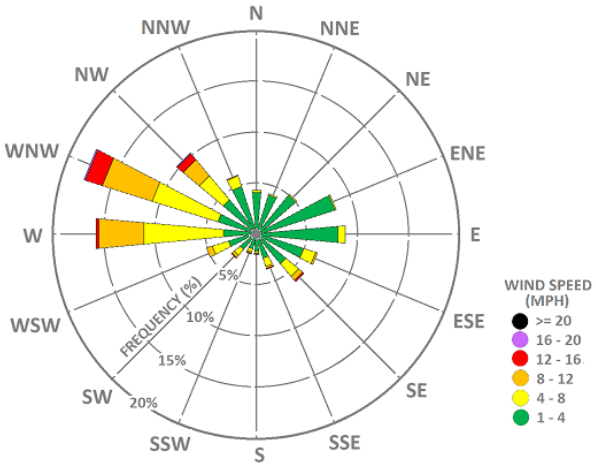
## Part 2: Air Quality Forecasting on Nipomo Mesa

Part 2 covers air quality forecasting on Nipomo Mesa, and how to identify projected wind conditions that can create Oceano Dunes particulate dust events.

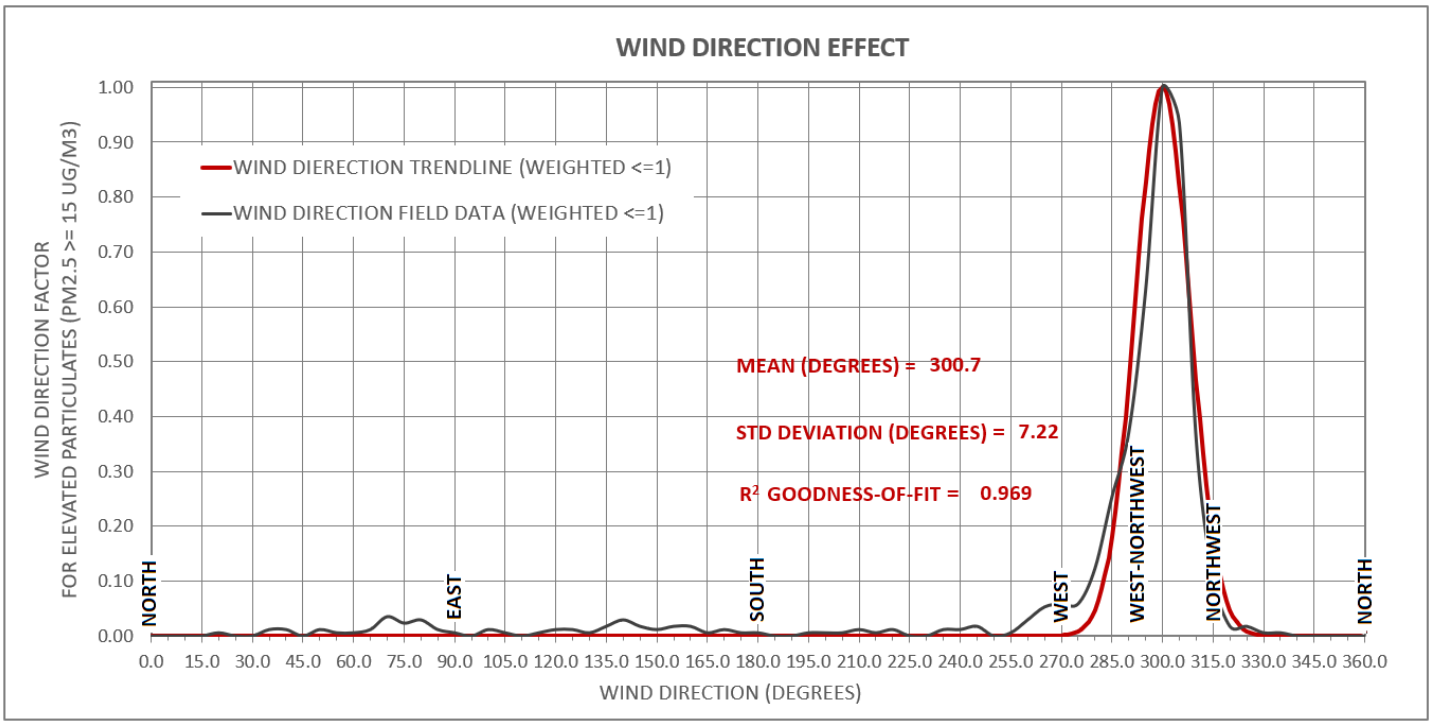
Previously, Part 1 mentioned how small changes in wind direction or speed can cause the dust plume to appear, disappear, or shift one way or another. The three accompanying charts can help us understand how dust events on the Mesa respond this way to wind conditions. A *Wind Rose Diagram* shows historical distribution of wind directions and speeds. The *Wind Direction Effect* graph shows the relationship between wind direction and air quality. The *Wind Speed Effect* graph shows the way sustained winds also relate to poor air quality.

**1. Wind Rose Diagram:** Historical Wind Rose diagrams are developed by measuring wind velocity over a period of years. The wind direction, frequency, and range of speed is displayed as colored spokes on a compass wheel. For example, consider the longest spoke on the diagram below, which shows West-Northwest winds. On average, WNW winds blow just over

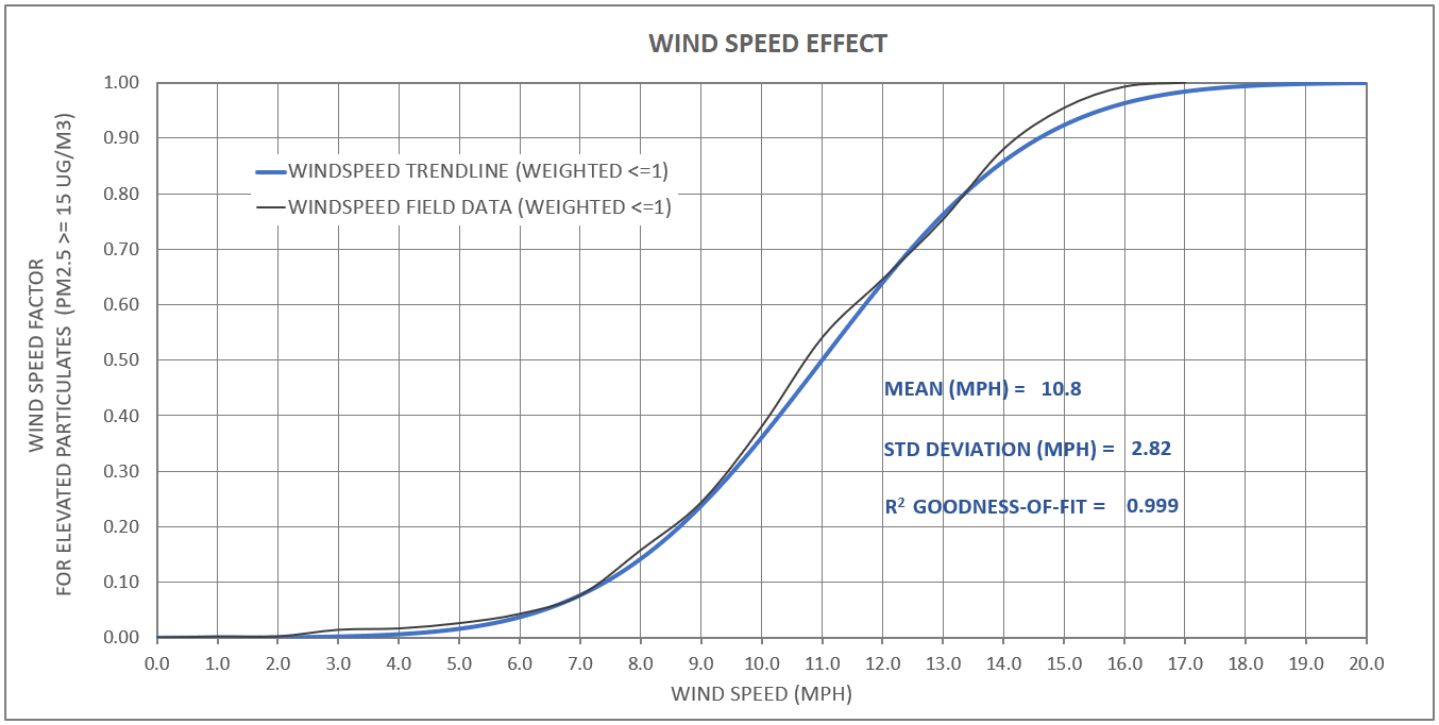
17% of the time. The size of the red band plus very thin violet band on the WNW spoke show sustained wind speeds are 12 MPH and higher about 2% of that time. These are 10-year averages, so there is seasonal variation where WNW winds will be more or less frequent.




**2. Wind Direction Effect Graph:** The graph below shows the likelihood of having elevated particulate levels from Oceano Dunes based on wind direction. The tall spike in the red 'Wind Direction Factor' line tells us there is a narrow band of wind directions that generate dust events. Anyone who lives on the Mesa knows this, but it also shows that the likelihood peaks at about 300 degrees – on the dividing line between WNW and NW winds. Getting more technical, if one standard deviations (about 7 degrees) is considered 'statistically significant', then wind directions between about 290 and 310 degrees are most likely to produce a bad air event – *but* on condition that sustained speeds are also strong enough to trigger a dust plume.



**3. Wind Speed Effect Graph:** When wind direction is within that narrow 290-310-degree band, this wind speed graph shows that the likelihood of a dust event increases rapidly with wind speeds above about 8 MPH. It also shows that wind speeds greater than 16 MPH don't make a dust event significantly more likely. At the lower end of this speed range, particle pollution doesn't extend very far into Nipomo Mesa. At the higher end, most of the western Mesa will see increased pollution.




**4. Predicting Dunes Dust Events:** From this model, a 'perfect storm' with near 100% probability of occurring would have sustained winds over 16 MPH from a WNW direction of 300 degrees. However, and the graphs only tell us when particulate levels are likely to be higher. They *don't* predict how high the level may get for any individual event. Still, when speed and direction factors are both high, it's usually associated with more pollution.

**5. Wind Conditions and Forecasts:** There are various online services that report the most current wind direction and speed, and also forecast future winds. One reliable global source to check is 'Windfinder.com'. You can zoom in to Nipomo Mesa from a world view. A direct link to Nipomo Mesa is: https://www.windfinder.com/#14/35.0399/-120.5566 . Clicking on a map location brings up its most recent reported wind conditions. Selecting future times and dates on the timescale at the bottom of the map will then display forecasted conditions.

**6. Technical Details:** The Wind Rose Diagram was developed from hourly wind velocity data from January 2010 through September 2019. The Wind Direction Effect and Wind Speed Effect

graphs were based on about 1,500 data points during 2018 and 2019 elevated particulate dust events, as measured at APCD's CDF BAM monitors. The Wind Direction curve fitting was based on a binomial distribution, and very closely fit field observations with an $R^2$ value of 0.969 (1.0 is perfect consistency). Likewise, the Wind Speed curve had an $R^2$ value of 0.999 when fit to a cumulative binomial distribution. These functions were part of a more comprehensive predictive model not discussed here. Within that model, an estimated probability of having a dust event is obtained by multiplying wind speed and direction factors together.

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## Part 3: Preparing Our Homes for Oceano Dunes Dust Events

This final part of the series covers steps we can take to protect indoor air quality in our homes.

Air quality on Nipomo Mesa is very good much of the time. However, when the wind direction and speed are just right, air quality can become very bad. Spring and Summer bring more frequent mid-day Northwesterly winds, and these can create conditions that pick up very fine particulates from Oceano Dunes. These aren't sand grains as some people think. They're microscopic dust particles that act like a gas when airborne. The particles accumulate in the lungs and create long-term health hazards.

It's possible for many Mesa residents to sidestep these health hazards. However, we would need to accept the inconvenience of rescheduling or cancelling our outdoor activities to avoid polluted air; and set aside our concerns for those of us who don't have the ability to reduce exposure – like agricultural field workers, industrial workers in construction or working at the refinery, or public safety and service employees like those in Public Works and CAL FIRE.

**Background and Progress**

The SLO County Air Pollution Control District and the California Coastal Commission have finally gotten some traction with State Parks to address particulate pollution from the most emissive Off-Highway Vehicle (OHV) riding and camping areas. As part of a multi-year project, Parks fenced off 48-acres in December 2019 to prevent OHV access and allow reestablishing and revegetating the foredunes. Foredunes are low sand dunes near the shoreline that can interrupt the air flow at ground level and reduce airborne particulates downwind.

During dust events, pollution coming from OHV riding areas has been shown to be several times higher than natural background emissions from non-riding areas. However, geologic history of the Dunes is also an important part of the air quality story. A 2019 study

(https://www.atmos-chem-phys.net/19/2947/2019/) shows that even natural background emissions from Oceano Dunes are higher than from other active sand dunes on the Pacific coast. According to the study, dune sand here is 'mineralogically immature', and sand grains are still coated with softer clay minerals. These clay-coatings break down more easily from wind abrasion and natural weathering than the underlying quartz sand grains. During dust events, the clays can increase fine particulate levels 2-3 times those of 'mature' sand sheets.

The naturally high background emissions from Oceano Dunes suggests it will always be important for Nipomo Mesa residents to consider their indoor air quality, even with significant improvements we expect to see in the future from dunes revegetation.

This bulletin only summarizes the commonsense steps you can take to protect your home. If you'd like to see a detailed report of what we've personally done in our home to combat Oceano Dunes dust pollution, email me directly at ssaltoun@physics.org.

**Protecting Indoor Air Quality at Home 1-2-3**

**1. Fix Air Leaks.** Seal drafty doors, windows, fireplaces and other potential access points for pollutants and allergens. An effective, low-cost method of locating air leaks is to close up the house, turn on all ceiling exhaust fans, and use a smoking incense stick to check for leakage.

**2. Filter Indoor Air.** Use high-efficiency air duct filters that capture PM 2.5 particles. (For example, 3M Filtrete 'Healthy Living' MPR 1900 and higher filters.) Fine particle buildup isn't visible to the naked eye, so regularly replace used filters. Running the furnace fan during dust events will often be sufficient in homes with air circulating systems to keep indoor air within the 'Green' range of EPA's Air Quality Index (AQI of 50 or less for PM 2.5.)

If needed, supplement duct filters with true HEPA room air purifiers (High-Efficiency Particulate Air Filters). These should be placed in bedrooms and main living areas to continuously circulate and clean indoor air. The image below is Consumer Reports 2019 test results for some of the true HEPA air purifiers on the market. Note that low-cost 'HEPA-type' filters are not as effective as true HEPA's.

**3. Monitor Indoor and Outdoor Air Quality.** There are many commercial indoor air quality monitors on the market, and outdoor air quality information can be found on several websites. Most home monitors have smartphone apps that allow us to see both indoor and outdoor information in one place. Some monitors also have built-in display screens, such as

the AirVisual Pro from IQAir. Very fine particles (PM 2.5) are usually the main pollutants of concern in most homes. However, airtight homes can build up carbon dioxide levels overnight, so monitors should also track $CO_2$ gas.

Knowing current air quality information can help us make better informed choices.

**Selected Air Quality Websites:**

**Outdoor Air Quality Information:**

SLO County Air Pollution Control District (APCD): County-wide air quality maps and forecasts:
https://www.slocleanair.org/air-quality/south-county.php
https://www.slocleanair.org/air-quality/air-forecasting-map.php

U.S. Environmental Protection Agency (EPA): Official air quality data displayed after the end of each hour for the past hour.
https://airnow.gov/

AirVisual Earth: Interactive air quality maps provide unified world-wide air quality information:
https://www.airvisual.com/earth
https://www.airvisual.com/air-quality-map

**Commercial Air Quality Monitor Research and Evaluations:**

South Coast Air Quality Management District (AQMD)
Air Quality Sensor Performance Evaluation Center (AQ-SPEC):
http://www.aqmd.gov/aq-spec/evaluations/summary-pm

**HEPA Filter Information and Reviews:** Many websites provide free HEPA filter reviews online. Consumer Reports uses very comprehensive testing protocols, but the current test report does not include several newer high-efficiency models. CR's top-rated true HEPA air purifiers are shown in the image below. To see the full report, you must subscribe.
https://www.consumerreports.org/cro/air-purifiers.htm

# Consumer Reports | Air Purifiers

**Test results**

Poor | Fair | Good | Very Good | Excellent

| Overall Score | Brand & Model / Price | | Dust/pollen/smoke removal (low speed) | Dust/pollen/smoke removal (high speed) | Noise (low speed) | Noise (high speed) | Ease of use | Room size | Annual cost ($) |
|---|---|---|---|---|---|---|---|---|---|
| OVERALL SCORE 88 | **Blueair** Classic 605<br>Recommended<br>Price: $665<br>Shop<br>Add to Compare |  | | | | | | L | 224 |
| OVERALL SCORE 85 | **Blueair** Blue Pure 211+<br>Recommended<br>Price: $300<br>Shop<br>Add to Compare |  | | | | | | L | 192 |
| OVERALL SCORE 76 | **Honeywell** HPA300<br>Recommended<br>Price: $250<br>Shop<br>Add to Compare |  | | | | | | L | 203 |
| OVERALL SCORE 69 | **Honeywell** 50250<br>Recommended<br>Price: $200<br>Shop<br>Add to Compare |  | | | | | | L | 213 |
| OVERALL SCORE 67 | **LivePure** Bali LP550TH-W<br>Recommended<br>Price: $300<br>Shop<br>Add to Compare |  | | | | | | L | 276 |
| OVERALL SCORE 65 | **SPT** AC-2102<br>Recommended<br>Price: $325<br>Shop<br>Add to Compare |  | | | | | | L | 395 |

| Overall Score | Brand & Model / Price | | Dust/pollen/smoke removal (low speed) | Dust/pollen/smoke removal (high speed) | Noise (low speed) | Noise (high speed) | Ease of use | Room size | Annual cost ($) |
|---|---|---|---|---|---|---|---|---|---|
| OVERALL SCORE 64 Add to Compare | **GermGuardian** AC5900WCA<br>Recommended<br>Price: $230<br>Shop |  | | | | | | L | 231 |
| OVERALL SCORE 64 Add to Compare | **Winix** FresHome WACP450<br>Recommended<br>Price: $220<br>Shop |  | | | | | | L | 112 |
| OVERALL SCORE 63 Add to Compare | **IQAir** HealthPro Plus<br>Recommended<br>Price: $900<br>Shop |  | | | | | | L | 293 |
| OVERALL SCORE 63 Add to Compare | **Kenmore** 83396<br>Recommended<br>Price: $220<br>Shop |  | | | | | | L | 187 |

# Appendix:

## Accessing Real-Time Information using the AirVisual Smartphone App

"Eucalyptus Roundabout" (EucRA is) an AirVisual public monitor site that reports average hourly readings on Western Nipomo Mesa at Woodlands/Trilogy. It has hundreds of 'followers' but only a relative few who apparently know that EucRA readings are actually updated every five minutes. These more frequent updates can provide near real-time qualitative information on local air quality.

To get EucRA five-minute updates, or change from hourly updates:

1. From the AirVisual home page ("Places" tab), tap on the three dots in the upper right corner of the screen.

2. Select "Follow Monitor" from the dropdown list.

3. Enter, and then 'Add' EucRA's "Share Code" (not case sensitive): woezmtax

4. OPTIONAL: If you were previously getting hourly EucRA updates, you will now see two 'widgets' on your home page for EucRA. Delete the 'widget' that only updates readings hourly (using the "Manage Places" button at the bottom of your home page.)

5. OPTIONAL: By default, the AirVisual app does not make any notifications, and five-minute updates are not automatic when the app isn't actively being viewed. However, you can elect to receive automatic screen or audio notifications whenever air quality is rapidly changing – based on parameters you set. To set notifications from your home page, tap the EucRA widget, and tap the 'ringing bell' icon at the bottom of the page.

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*Prepared by Sam Saltoun, 6 February 2020 (originally published as a three-part series in 2019 in MyTrilogyLife Bulletins.)*