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DATE: June 19, 2014

TO: SJVUAPCD Governing Board

FROM: Seyed Sadredin, Executive Director/APCO
Project Coordinator: David Lighthall

RE: ITEM NUMBER 11: PRESENTATION OF RESULTS FROM DISTRICT PARTICULATE MATTER SPECIATION RESEARCH PROJECTS

BACKGROUND:

Moving beyond the conventional focus on mass reduction, the District's Health-Risk Reduction Strategy (HRRS) prioritizes air quality strategies that achieve maximum benefits to public health. To build the necessary scientific foundation for this approach, the HRRS has played an important role in shaping the District's health research agenda. A particular area of focus has been to make concrete measurements of Valley health outcomes in relation to ozone and PM2.5 exposure as well as to the chemical species that comprise PM2.5.

Reflecting the District's leadership in funding innovative health research, your Board funded in 2010 the San Joaquin Valley Epidemiological Study. Spanning the years 2002-2007, the study found significant correlations between daily rates of the following health outcomes and high levels of daily PM2.5 in Modesto, Fresno, and Bakersfield:

1. Asthma ER admissions for adults (+ 20 years)
2. Asthma hospitalizations for children (1-19 years) and adults
3. Pneumonia ER admissions for children
4. Acute bronchitis ER admissions for adults
5. Adult acute myocardial infarction (heart attack) hospitalization

The key indicator for demonstrating association was the relative risk (RR) metric. For example for 2005-07 among ages 1 to 19, an increased RR of nearly 1.5 was found for ER admission on days when the average 24 hour PM2.5 mass was among the highest 20% (quintile) of all winter days (all cities combined). A RR of 1.5 meant a 50% greater chance of admission when compared to the cleanest 20% of winter days, a RR of 1.4 equals 40% greater risk, etc. In addition,

the relative risk for the other quintiles was lower in proportion to their average PM2.5. In other words, daily rates of ER admission for children closely tracked PM2.5 levels at a very high level of statistical significance. Other cardiovascular and respiratory illnesses also tracked daily PM2.5 levels at lower degrees of statistical significance. Study results were segregated between children (1-19) and adults (20+). While these results confirm the previously established relationship between PM2.5 mass and health impacts, there is a growing recognition that these impacts are disproportionately caused by a subset of the chemical species that comprise PM2.5.

As a follow-up, your Board authorized two additional studies to measure the spatial variation of PM2.5 species and their health impact in the San Joaquin Valley. In June 2011, your Board authorized the Speciated PM 2.5 Valley Epidemiology Study at a cost of $54,578 to determine if there are statistically significant daily associations between elevated exposure to individual PM2.5 species and elevated admission rates to local health facilities. The second study, Spatial and Seasonal Variability of Fine Particles in Urban Neighborhoods of the San Joaquin Valley, was authorized in October 2012 at a cost of $149,915. The study measured neighborhood-scale differences in population exposure to particular sources by saturating urban areas with many low-cost passive samplers. Completed in 2014, both studies share a common focus on PM2.5 speciation as a unique means of linking Valley emission sources, the PM2.5 species of most concern, and the health effects they generate. The discussion below summarizes the unique aspects of each study and their findings.

DISCUSSION:

Speciated PM 2.5 Valley Epidemiology Study: In the Speciated PM 2.5 Valley Epidemiology Study, hospital and ER rates for the same three cities were employed but the timeframe was extended by three additional years, 2008-2010. Most significantly, in addition to daily PM2.5 concentrations from central monitors, UCSF-Fresno researchers made use of speciated PM2.5 data that is derived from the same monitors every third day. This made it possible to see if the varying daily concentrations of individual species such as organic carbon were statistically associated with hospital or ER admission rates for the key diseases in addition to daily PM2.5 mass. An important statistical tradeoff was the one third fewer winter days when species concentration levels were available. In addition, due to failure of the state agency to provide UCSF-Fresno with the full dataset on a timely basis, researchers were not able to segregate results between adults and children. With full results to be included in the Board presentation, highlights of findings include the following:

1. Daily wintertime PM2.5 levels decreased in the latter years (2008-2010), while asthma ER visits increased significantly during the same time period. Consequently, the magnitude of correlations between daily PM2.5 levels and asthma ER visits were diminished over the six year period (2005-2010) relative to the previous results (2005-2007), and were not statistically significant.

2. The researchers found that increases in upper respiratory infections or URI during the latter winters (2008-2010), as evidenced by similar increases in URI-related ED visits, were significantly correlated with asthma ER visits rather than daily increases in PM2.5 mass levels.
3. Although PM2.5 mass concentrations were not significantly associated with asthma hospital or ER visits, organic carbon and potassium levels were correlated with increased risk of asthma ER visits during the six year study period (2005-2010). In contrast, ammonium nitrate and elemental carbon were not correlated to asthma hospital and ER visits. Potassium is a key indicator of residential wood combustion (RWC) and organic carbon results from a variety of hydrocarbon and biomass combustion sources.

The findings are a reminder of the complexity of factors and processes that shape public health outcomes in the San Joaquin Valley, particularly in respect to asthma. Depending on the time of year, District-funded health studies have made it clear that asthma attacks occur from a variety of drivers that may or may not be related to anthropogenic PM2.5 or PM10. As seen in the Valley Epidemiology Study, the highest rates for children's' asthma ER admissions are in the spring when PM2.5 levels are low and allergens are high. And, as seen in this latest study, outbreaks of upper respiratory infections can be a more predominant trigger of wintertime asthma ER admissions than PM2.5.

Spatial and Seasonal Variability of Fine Particles in Urban Neighborhoods of the San Joaquin Valley: The primary goal of the study was to better understand the intra-urban or neighborhood-scale variability of exposure to primary (directly-emitted) PM2.5 and PM10 species within the metro environment of Fresno, and to a lesser extent Bakersfield, through a relatively dense deployment of low-cost passive samplers mounted on light poles 13 ft. above street level. A unique technical aspect of the study was the elemental speciation of all individual particles collected by the samplers in the 0.2 to 10 micron diameter range. This made it possible to identify the most likely sources of the particles on the basis of their chemical signatures. Particles were collected over the course of month-long winter and summer campaigns. Upon completion of sampling, a highly sophisticated scanning electron microscope was used to estimate the size, shape, density, weight, and elemental composition of each particle. PM2.5 and PM10 mass for each sampler was also calculated. Site to site variability in PM exposure was also analyzed.

The elements measured in this study included carbon (C), sodium (Na), magnesium (Mg), aluminum (Al), silicon (Si), phosphorus (P), sulfur (S), chlorine (Cl), potassium (K), calcium (Ca), titanium (Ti), chromium (Cr), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), barium (Ba), and lead (Pb). By analyzing the particular combination of elements that made up each particle, it was possible to identify the most likely source of the particle. In keeping with the focus on primary aerosol sources, secondary and/or semi-volatile aerosol species such as ammonium nitrate (AN) were not collected on the samplers. However, the elements measured do correspond well to those PM2.5 species that are most associated with negative health effects, including

carbon and metals such as iron and nickel. Because of seasonal differences in meteorology such as relative humidity, there are some differences between winter and summer source category assignments.

Pairs of passive samplers were installed at 14 neighborhoods in the Fresno-Clovis metro area and four neighborhoods in Bakersfield. Paired samplers were located in Kettleman City and Fairmead, and one sampler was installed at the District monitoring sites in Corcoran, Madera, Modesto, and Turlock.

Key results include the following:

1. Engine oil burning and cooking/residential wood combustion particles were identified as the major sources in the winter samples. To capture the full magnitude of overall contribution to PM2.5 mass from these sources, the secondary species related to these sources must also be included.
2. Summer samples were predominated by mineral dust, crustal particles, and re-suspended road dust, totaling 43% of total PM2.5 mass.
3. Source categories such as crustal, soil/metals, and mineral dust are closely related in terms of chemistry and sources.
4. Carbonaceous soot generated by hydrocarbon combustion was also dominant in the summer samples (15%).
5. Landscaping activity accounted for 4% of the PM2.5 mass in the summer samples. This did not include landscaping engine emissions (assigned to carbonaceous soot) or re-suspended dust from neighborhood landscaping.
6. The study found many differences in relative source impacts across neighborhoods in both Bakersfield and Fresno.

These findings support the conclusion that even though the District's main particulate attainment challenge under the Clean Air Act has and will continue to be wintertime PM2.5 mass concentrations, health risks from localized, ground-level sources of PM2.5 such as vehicular exhaust, re-suspended road dust, landscaping activities, and charbroiling are present year round. By extension, these results validate the District's emphasis under the HRRS on a source-oriented control strategy that prioritizes net health risk reduction in conjunction with attendant reductions in PM2.5 mass.