Perelman School of Medicine
University of Pennsylvania
Center of Excellence in Environmental Toxicology (CEET)

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Good Morning. I am Dr. Marilyn Howarth, an Occupational and Environmental Medicine physician and Director of Community Engagement at the Center of Excellence in Environmental Toxicology at the Perelman School of Medicine at the University of Pennsylvania. The Center of Excellence in Environmental Toxicology would like to thank State Senator Anthony Williams and the Senate Environmental Resources & Energy Committee for the opportunity to submit this testimony regarding the environmental health impacts of PES refinery, refinery fire, its shutdown and potential reuse of the site.

The Center of Excellence in Environmental Toxicology (CEET) is the University of Pennsylvania's P30 Environmental Health Sciences Core Center (EHSCC) funded by the National Institute of Environmental Health Science (NIEHS). It is the only EHSCC in Pennsylvania and the only one in EPA Region III. The environmental health researchers, physicians and public health professionals of the CEET work every day on environmental health issues that affect our region and recognize the value of scientific evidence to establish and maintain public policy protective of human health.

To appreciate the impact of the PES refinery on the health of Philadelphia residents requires background on the health outcomes that are relevant to its emissions and releases. The National Cancer Institute estimates that Philadelphia has the highest cancer rate of any large city in the US. 541 people in every one hundred thousand in Philadelphia will get cancer compared with 442 in the US (NCI) and 494 in PA (PA County Health Profile). In Philadelphia, the rates of cancer are higher than Pennsylvania rates in colon and rectal cancer, lung cancer, kidney cancer and prostate cancer. Several of these cancers are caused by environmental exposures. The refinery pollutant benzene is linked to leukemia and kidney cancer and particulates are linked to lung cancer. The World Health Organization, International Agency for Research on Cancer has listed air pollution as a known Group 1 human carcinogen and estimates that this contributes to 230,000 new lung cancer cases per year.

Asthma hospitalization rates are three times higher in Philadelphia than Pennsylvania according to the Pennsylvania Department of Health. So too are Philadelphia's rates of hospitalization for heart attacks and chronic obstructive pulmonary disease. All of these significant health disparities occur in a city whose medical care is considered to be among the best in the country. Certainly, there are many contributors to each of these health outcomes however, the volatile organic compounds emanating from a refinery over years and particulates that were visible in the sky during fires significantly increase the exposure to hazardous air pollutants to residents of Philadelphia and the environs.

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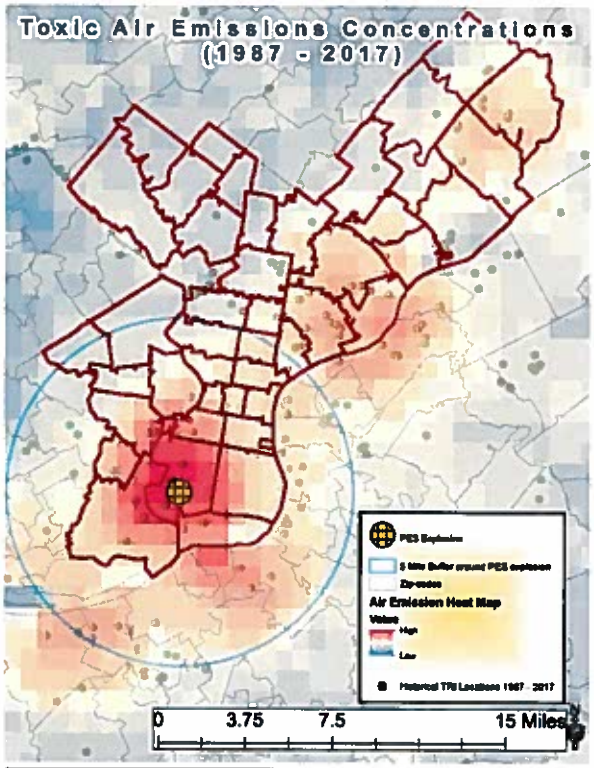

Fig 1: Toxic Air Emissions in Philadelphia
source: EPA Toxic Release Inventory

The PES refinery is the largest emitter of volatile organic chemicals in the region (NEI,2014). More than four hundred thousand pounds of hazardous chemicals are emitted into the Philadelphia air every year according to the EPA's Toxic Release Inventory from the PES refinery. More than 10% of the emissions are carcinogens or pre-carcinogens changed into carcinogens in the body. Figure 1 shows the toxic air emission concentrations from point sources in Philadelphia. The refinery stands out as the largest emitter impacting the surrounding neighborhoods. In 1999, a health assessment conducted for the EPA found that lung cancer incidence in the proximity of the refinery was 40% higher than the national average. Knowing that a latency period of more than 20 years exists between exposures and cancer onset indicates that we cannot be complacent about any recent gains in air quality.

In addition, since the passage of the Federal Clean Air Act in 1970, Philadelphia has never been in compliance with it for Ozone. Ozone is a criteria air pollutant formed in the atmosphere when volatile organic compounds and nitrogen oxides react in the presence of sunlight. Ozone is a potent irritant that causes asthma and leads to asthma exacerbations in people who have asthma. In addition, as little as one to two hours of elevated levels of ozone exposure increases heart attack rates and heart rhythm disturbances that lead to sudden death. According to the PA DEP, the PES refinery was out of compliance with its permits for each of the last 12 quarters. That means for the last 3 years, it was never meeting its permits, spewing unauthorized contaminants in the air for residents to breathe. Given the size of the large refinery complex, its significant health impacting emissions and the close proximity to millions of Philadelphia residents, we conclude that permits for this type of industry in this location would not be granted in the future.

The recent fires at the PES refinery have led to many questions about the preparedness of Philadelphia Air Management (AMS) to quickly identify airborne hazards and adequately protect people. On-site monitoring systems should always provide the initial data on releases including those from a fire. However, immediate community level

monitoring should be in place in particular when the emissions could have catastrophic health consequences. In the case of the PES refinery, pre-planning should have identified hydrofluoric acid (HF) as a potential hazardous emission and community level monitoring should have been immediately set up for this deadly chemical known to travel for several miles from the emission source (Dayal, 1992). Even if the on-site monitoring did not show elevated levels, reliance on those monitors alone is not adequate to protect public health because the situation changes quickly in a fire and explosion scenario. Also, monitors can be damaged or destroyed as they were in this case (personal communication EPA). AMS used hand held HF monitors in the first hours after the explosion and fire which occurred at around 4 AM. When AMS monitors in a nearby neighborhood detected elevated levels of HF the EPA was asked to provide confirmation but this did not occur until 10 AM by which time HF may have been long gone. Had there been a substantial HF leak, many residents would have been exposed leading to permanent lung damage and possibly death as have occurred in several other refinery HF leaks in the US (Horton,2004). An example of the effects of an air borne leak of HF can be seen in an industrial accident in Texas in 1987. In that case 24,000 kg of HF were released into the air leading almost 1,000 of the 41,000 residents to seek medical care. 94 were hospitalized with respiratory illness, some with long-term symptoms. The air levels of HF one hour after the leak were 10 ppm and 'minimal' at two hours. In Philadelphia, the PES refinery is reported to have 190,000 kg of HF on site, almost 8 times what was released in Texas (Dayal, 1992). The implications for release of even half of PES's HF would be catastrophic.

Philadelphia has stationary real-time monitors deployed for purposes of regional air monitoring to determine compliance with the Clean Air Act, none of these monitors detected elevated levels of chemicals while residents smelled acrid odors and saw black clouds of smoke for hours. Dr. Peter DeCarlo, Associate Professor of Civil, Architectural and Environmental Engineering at Drexel University and a researcher at our Center of Excellence in Environmental Toxicology at the University of Pennsylvania has analyzed air monitoring data and modeled air flow and documented the inadequacy of the current response and the false reassurance given to the public based on inadequate monitoring. I refer you to his written document where graphs and maps delineate the problems. Hopefully, the lesson learned is that the existing monitoring system should not be assumed to be appropriately placed when considering the rapid deployment of monitoring to protect people. In addition, refineries around the country are using safer alternatives to hydrofluoric acid and we strongly recommend that hydrofluoric acid not be permitted for use within Philadelphia given its dense population in the future.

The closure of the refinery alone, should substantially improve the ozone levels in Philadelphia leading to improved regional compliance with the Clean Air Act and reduced asthma hospitalizations and heart attacks. There are many other air pollution emitters in Philadelphia and the effects on people of these emissions are cumulative. In

other words, the relatively small emissions of multiple polluters are experienced by people as much greater cumulative exposure that continually bombards the lungs, heart and other organ systems. Regulators of air pollution sources do not currently have an effective quantitative process for establishing individual permit limits that consider the cumulative impact on the population of the multiple sources of air emissions in cities where many are permits are requested. The regulatory process considers each permit in isolation determining how much of each pollutant that source can add to the air. On the face of it, the process seems like the fairest approach. However, it is ultimately unfair to the residents of the city when each additional exposure allowed by each new permit issued increases the health risk. In fact, this process is not in keeping with the environmental rights amendment of the PA constitution Article 1 Section 27 that guarantees each Pennsylvanian the right to clean air, pure water and the preservation of the natural scenic historic and aesthetic values of the environment. Understanding that Philadelphians are not well protected by the current regulatory process should help guide the future use of the PES refinery property. Replacing the refinery with a similarly polluting industrial process will pose substantial health risks to Philadelphia residents. We understand that an economic driver is to preserve jobs but there is another economic driver which is the cost of providing health care for chronic illness and lost days at work or school due to that illness. These associated costs also affect the most vulnerable, our children and the elderly.

Legacy pollution at the PES refinery location must be considered in the plans for future use for the site and potential for ongoing health impacts to people. The site is in the midst of a PA Act 2 remediation with clean-up levels clearly in the industrial re-use range. The Philadelphia community has not been involved in the evaluation of the remediation plans or the establishment of clean-up levels as required by Act 2. Perhaps this is why the established clean-up levels are extremely high. The soil and ground water contamination that exists throughout the property is believed to have occurred mostly in the more than 100 years of the refinery's operation prior to Federal and State environmental regulation. During that time period, it is estimated that up to 53,000 barrels of gasoline each month was lost into the soil and ground water due to leaking and spills (Quivik,2015). The contaminated soil abuts the hard shore bulkhead (DEP internal memo 3/22/19) at the Schuylkill River, a main source of drinking water for Philadelphia. The ground water has not been a source for drinking water for Philadelphia but the deeper aquifer is a drinking water source for NJ. Recent data for the deeper aquifer has not been published on the Act 2 site as required by the DEP, so it remains unclear what the current risk to NJ drinking water supplies is (Final Report AOI 11, 6/21/13). This widespread contamination would certainly meet criteria for a Superfund site but the EPA and PA DEP allow for the remediation to proceed under a hybrid process where EPA determines RCRA and CERCLA compliance while the DEP determines state regulatory compliance under Act 2. Sunoco, the responsible party, has decided that they will pursue a site-specific clean up option rather than the stricter background standards or state-wide health standards. The selection of site-specific

clean-up standards ensures that this property would not be safe for use for anything other than industrial purposes. This would be a permanently lost opportunity for the 1,400 acre land mass in the City of Philadelphia. A good example of how settling for site-specific standards could impact health is found in their site-specific standard for lead. The EPA has determined that a safe level of lead for bare soil in a child's play area is 400 ppm while at the same time the EPA accepted a site-specific standard for PES refinery clean-up of 2240 ppm. Ironically, on the same day as the PES refinery fire, the EPA came to Philadelphia to announce that based on the evolving data of the harm of extremely small amounts of lead they were lowering the acceptable house dust and window sill levels of lead to better protect children. We know that 50% of house dust occurs from tracked soil from the outside. Tracked in soil containing 2240 ppm lead could easily exceed the 10 mcg/ft^2 on floors. This is just one of the hazardous chemicals known to be contaminating the soil and ground water at the PES site. Vapor intrusion studies in buildings on the site have found levels of carcinogens in the air above state-wide health standards (DEP memo 3/22/19). If the current site-specific standards are kept in place this property will be so restricted that few industries would be willing to work there because any soil disruption would pose an unacceptable risk to human health. By allowing the site-specific standards to remain in place, any future remediation beyond these standards would be the responsibility of the Commonwealth since the responsible party would have been deemed to have met their obligation.
In summary, researchers, medical doctors and public health professionals at the Center of Excellence in Environmental Toxicology are very concerned about the ineffectual monitoring portion of the emergency management of the fire at the PES refinery that could have led to serious public health impacts given the current response plan for monitoring the air. We recommend that decisions that have established clean-up levels at the property committing it to industrial use for the foreseeable future be re-considered because the proximity of large-scale industry of any kind in the middle of Philadelphia may pose undo risk to public health. We also strongly recommend that legislators remedy the inadequate public participation process that has been the practice as the remediation plans are developed. We would gladly bring scientific expertise and join community members to allow for improved public engagement. Thank you for your attention and for the opportunity to submit these comments.

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References:

Dayal, H.H., M. Brokwick, R. Morris, et.al.1992. A community-based epidemiologic study of health sequelae of exposure to hydrofluoric acid. Ann. Epidemiol. 2(3):213-230.

Horton, K.D.; Berkowitz, Z; Kaye, W. E. 2004. Hydrofluoric Acid Releases in 17 States and the Acute Health Effects Associated, 1993–2001
JOEM. 46(5): 501-508.

National Cancer Institute 2012-2016 accessed 7/19/19
https://seer.cancer.gov/statfacts/html/all.html

National Emissions Inventory 2014 Version 2, Database. Washington, DC US EPA 2014 https://gispub.epa.gov/neireport/2014/

Pennsylvania County Health Profile, Philadelphia County accessed 7/15/19
https://www.health.pa.gov/topics/HealthStatistics/VitalStatistics/CountyHealthProfiles/Documents/current/philadelphia.aspx

Quivik, F.L. 2015. "Abundance, Dependance and Trauma and Philadelphia's Point Breeze Petroleum Refinery: A Mirror on the History of Pennsylvania's Oil Industry." *The Pennsylvania Magazine of History and Biography* (The Historical Society of Pennsylvania) 139(3):265-292.

DEP memo from Richard Staron to Ragesh Patel dated 3/22/18 re: ECB- Land Recycling Program Act 2 (all pages dated 3/22/19)

Final Report AOI 11 PES Refining and Marketing LLC Facility Philadelphia, Pennsylvania. prepared by Langan Enginineering & Environmental Services, Inc. June 21, 2013

PA DEP Air Permit Compliance: https://echo.epa.gov/facilities/facility-search/results

Assessment of Air Quality Monitoring during PES Fire
Peter DeCarlo, Ph.D.

During the massive fire at PES many area residents were concerned about the potential air quality impacts of the fire. At the time city officials consistently reassured people that there was no adverse air quality impact, even though clear smoke plumes were visible from the fire. Air quality measurements were made at fixed sites as part of the regulatory network of the city, several air samples were taken and assessed for volatile organic compounds by the city, and some handheld monitoring was done. The below discussion indicates where issues with air quality monitoring for each of these methods arise, and suggests that much of the city's messaging on air quality surrounding the fire was based on false negatives. Simply put, air quality was not measured in the right place, or with the right equipment and thus led to an erroneous assessment of air quality impact.

Fixed sites

Philadelphia Air Management locations not suitable for monitoring fire due to wind direction. Camden was potentially downwind, but only briefly as wind turned south. The Figures below show where PM is monitored in the region, and the expected plume travel and dilution downwind.

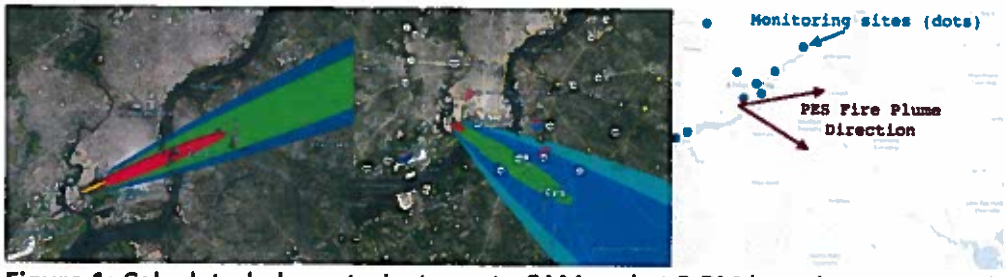


Figure 1: Calculated plume trajectory at ~6AM and at 2 PM based on measured meteorology. Locations of PM monitoring sites in the PA/NJ area and the direction of the fire plume

PES up/down wind monitoring sites just posted data. The so-called "downwind" site showed a significant spike of $PM_{2.5}$ and PM_{10} for 2+ hours (hourly data) with concentrations exceeding 60 $\mu g\ m^{-3}$ and 80 $\mu g\ m^{-3}$ for $PM_{2.5}$ and PM_{10} respectively. The figure below shows the PM2.5 concentrations at 2 Philadelphia Air Management measurement sites as well as the montoring done by PES as part of the consent decree with the City and EPA region 3.

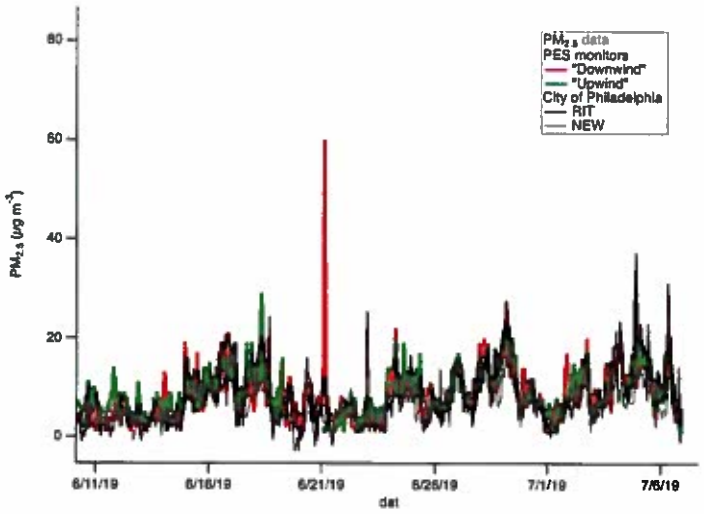


Figure 2: PM2.5 concentrations measured by the City of Philadelphia and PES on site. The spike in PM2.5 on 6/21 is due to the fire, and shows elevated concentrations for several hours.

Handheld monitors

HF monitoring by Philadelphia Air Management Services measured elevated HF at a location near PES. There was concern this was a false positive, and PES personnel later measured at the same location without HF detected. This is concerning since HF if released as a "puff" would not remain in the same location for an extended period of time. The positive measurement should have been cause for proactive measures to protect residents. A negative reading hours later in no way confirms a false positive.

Additional handheld sampling was conducted with multiRAE instruments (https://www.raesystems.com/products/multi-gas-detection/multirae-family-multi-gas-monitors). These instruments while convenient to use and available to borrow are not suitable for outdoor air quality monitoring. The measurement detection limits and sensitivity are not sufficient for detecting elevated levels of pollutants from the fire. These instruments were also only set to monitor for a few select species, and not typical AQ pollutants (e.g. criteria pollutants or HAPS). Species monitored with the multiRAE systems included: Gamma radiation, Lower Explosive Limit, Carbon Monoxide, Hydrogen Sulfide, and Oxygen. Of these species only Hydrogen Sulfide and CO are considered pollutants related to air quality, but the sensors in the MultiRAE instruments are too coarse resolution to have meaningful input into AQ levels. Typical H2S concentrations monitored at the refinery are less than 1 part per billion. The detection limit for the H2S in the multiRAE detector is 100 parts per billion, this is inadequate to assess whether there was an exceedance of H2S due to the fire at PES. For Carbon Monoxide, the detection limit of the MultiRAE instrument is 1 part per million or 1000 parts per billion. Typical concentrations in Philadelphia are 250 parts per billion, and seldom exceed 1 part per million. The MultiRAE instrument is not suitable for an assessment of outdoor air quality impact from the fire if the measurements are not sensitive enough. Fundamentally, these instruments provided false negative readings which were then used in messaging to residents about how there was no adverse AQ impact from the fire.

Canister sampling for VOCs using the TO-15 protocol

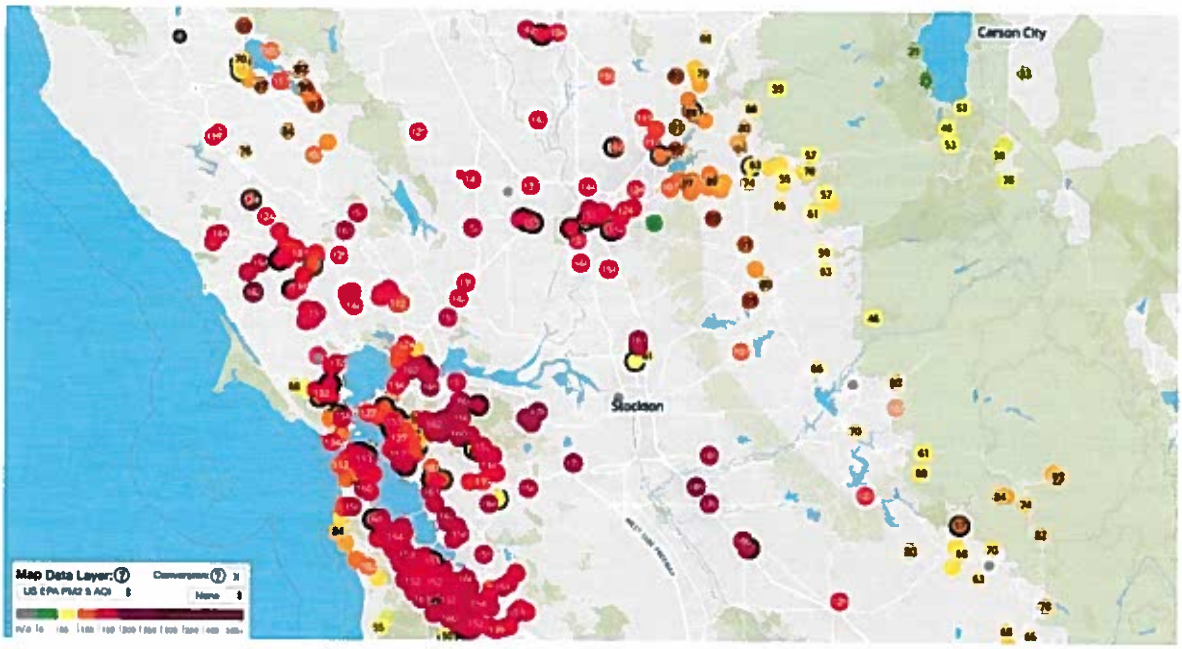
Two hours after the explosion, two canister samples were taken. One canister was upwind of the fire, the other downwind. Exact locations are not clear from the data, but the downwind sample mentions a parking lot. Ultimately the results of these 2 samples did not indicate significant concern for the measured species. This sampling, unfortunately, was inadequate. Only two samples taken, and only 1 of them in a "downwind" location is insufficient for assessing the impact of the fire over a larger spatial area. With many reports of residents complaining of smells during the fire and after, it is concerning that more measurements were not taken, and especially measurements in the neighborhoods downwind of the fire. Under-sampling of the air quality in the wake of the fire is not protective of the resident health, and it is not clear why more aggressive sampling was not done.

Lack of PM sampling

One of the main pollutants emitted from a fire is particulate matter. This is often called soot and is the product of incomplete combustion. The visible smoke plumes are clear indication of this pollutant, and the photos and video of the fire throughout the day indicated that this was a consistent emission, however there was no attempt to measure this by Philadelphia Air Management services. Perhaps this is due to the lack of portable $PM_{2.5}$monitoring instruments, but it remains a large oversight in the assessment of air quality during and in the wake of the fire.

Looking forward

Lessons can be learned from other areas which deal with fire emissions. Two important examples of fire monitoring can be suggested as a way to be more prepared for other incidents in the future. In Montana where forest fires are common in the summer time, monitoring agencies have portable E-BAM measurements ($PM_{2.5}$) that can be deployed rapidly in downwind areas to assess the impact of the fire on local air quality. These devices provide a flexible multipoint measurement using a federal reference measurement standard. Investment in these monitors is expensive, but invaluable when accidents such as PES (or other industrial accidents) occur. A non-FRM/FEM measurement standard is to use low cost sensors. During the forest fires in California last year, low-cost sensors by purple air helped show where the air quality was most impacted see: https://www.cnet.com/news/california-fires-boost-interest-in-purpleair-air-pollution-sensors/



PurpleAir's air quality sensors feed data into a map anyone can see. This screenshot shows bad air quality in the San Francisco Bay Area and the number of people who've installed the sensors.

Screenshot by Stephen Shankland/CNET

Figure 3: Purple Air map of air quality index from sensors measuring in Northern California during the wildfires from summer of 2018.

While the accuracy of the monitors is poor, they were approximately twice as high as the federal reference methods measuring simultaneously, the density of the sensors helped residents have an idea of where the plumes were and where air quality was affected. Unfortunately, South Philadelphia had no low-cost sensor network, and we were therefore not able to leverage the measurement capabilities of such a sensor network.

Retrospective:

Air quality monitoring during the PES fire was not done effectively. This is in part due to the regulatory network of fixed site monitoring being poorly situated in relation to the fire plume. Additionally, however, use of handheld monitors that are not suitable for outdoor air quality monitoring contributed to messaging by city officials that relied on false negatives. At the same time a positive (perhaps false positive) reading of HF was not discussed by city officials. In the future better and more flexible air quality network design and improved monitoring should be in place so that the city can appropriately respond to air quality issues in the future.