RE: **Statement on the Health Effects of Refineries and Implications for the S Philadelphia Refinery**

TO: The City of Philadelphia Refinery Advisory Group

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There are a number of pathways by which refineries -- in particular the South Philadelphia oil refinery -- could impact health, including: **air pollution**, **contamination of waterways and soil**, and **psychosocial stress** from living near a hazardous site (Prioleau, 2003). Oil refineries continuously emit air pollutants thus making air pollution one of the primary pathways by which refineries affect health. Many air pollutants, such as fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), ozone, sulfur dioxide (SO_2), and certain volatile organic compounds (VOCs), are well-known to be harmful to human health (NRC, 2005). The South Philadelphia refinery complex has been the largest point source emitter in the city for several of these pollutants ($PM_{2.5}$, SO_2 and VOCs which include benzene) (EPA, 2014). In recent years, the refinery was responsible for approximately 90% of Philadelphia's point source benzene emissions and approximately 70% of Philadelphia's point source SO_2 emissions (Simeone, 2018).

While no studies have focused on the direct impact of the South Philadelphia oil refinery on health, several studies have documented the impact that air pollution from oil refineries have on **respiratory health outcomes**. Air pollutants near oil refineries - specifically, NO_2, $PM_{2.5}$ and SO_2 - have been associated with increased respiratory illnesses among residents living proximal to the refineries. Research has documented increases in asthmatic episodes, wheezing symptoms, and an overall decrease in lung function in children (Alwahaibi & Zeka, 2016; Barbone et al., 2019; Brand et al., 2016; Rusconi et al., 2011; Smargiassi et al., 2009; White et al., 2009).

Negative birth outcomes, cancer, and other health outcomes have also been associated with refinery emissions. A few studies found that women were more likely to deliver preterm infants if they lived closer to a refinery (M. C. Lin et al., 2001; Yang et al., 2004). The VOC benzene is emitted by refineries and is known to affect many critical organs and is a known carcinogen (Loomis et al., 2017). Benzene emitted during a prolonged refinery flaring event was implicated in altered/impaired liver function among residents in the surrounding area (D'Andrea & Reddy, 2016a, 2016b). Although findings have been inconclusive, work to date suggests that persons living near refineries have higher cancer risk than the general population (Barregard, Holmberg, & Sallsten, 2009; C. K. Lin, Hung, Christiani, Forastiere, & Lin, 2017; Yuan et al., 2018).

Surrounding neighborhoods are particularly vulnerable to the health effects of the refinery

In general, pollutants from the South Philadelphia refinery have not been well-measured in the neighborhoods surrounding the plant. Nevertheless, based on data from the Philadelphia area, refinery monitoring conducted in other communities, and dispersion models (Alnahdi, Elkamel, Shaik, Al-Sobhi, & Erenay, 2019), it is apparent that communities within 5 kilometers (3.1 miles) of the refinery have much higher exposure than Philadelphia as a whole. In 2016, the U.S. EPA found decreasing concentrations of chemicals found in oil (benzene, toluene, ethylbenzene and xylene [BTEX]), with increasing distance from the South Philadelphia refinery site (Mukerjee et al., 2016; Thoma et al., 2016). Monitoring studies in other cities have found that

elemental carbon was more than 10 times higher in a refinery neighborhood than in the city as a whole (Polidori, Kwon, Turpin, & Weisel, 2010).

Living near a large industrial site can be a source of stress, anxiety disorder, and depression among neighborhood residents (Downey & Van Willigen, 2005; Kondo et al., 2014). The community is extremely concerned about the refinery's known/documented hazards (DESMOG & Kelly, 2019). Most months, the refinery owner, Philadelphia Energy Solutions (PES), acknowledged numerous equipment and operator malfunctions that resulted in emissions that exceeded regulatory thresholds (PES, 2018). In addition, another source of community concern is that there is incomplete information from hazard monitoring systems (WHYY & Jaramillo, 2019). PES acknowledged numerous incidents where their monitoring equipment was not functioning (PES, 2018) and some experts warn that independent/government agencies have not collected information that could be used to comprehensively assess hazards to the community (Mulcahy, 2019).

Health impacts due to catastrophic failures - chemical leaks/ releases/ explosions

Plant failures involving highly corrosive chemicals used in the refinery process pose a lethal risk to workers on-site and potentially catastrophic risk to the community at large. The South Philadelphia refinery June 2019 explosion occurred at a leaking alkylation unit that used hydrofluoric (HF) acid, a corrosive agent that is used in approximately 10% of refineries. Approximately 5200 pounds (2.6 tons) of HF acid was released. Fortunately, workers on-site reported only minor injuries. The community's health effects have not been documented. Nevertheless, it should be noted that ambient pollutants from the refinery could affect the health of over one million residents downwind of the refinery (PI & Maykuth, 2019b).

Explosions/fires and subsequent releases of corrosive agents at other refineries demonstrate the devastating effects that refineries can have on local communities. In 2001, an explosion at a Delaware City refinery, released spent sulphuric acid which killed one worker, injured numerous others, and contaminated the Delaware River, resulting in thousands of dead fish and crabs (EPA & DOJ, 2005). In 2012, an explosion at a Richmond California refinery released sulfuric acid and NO_2, which resulted in 15,000 residents seeking medical attention (CSB, 2015).

Conclusions and recommendations

In conclusion, there is ample evidence of the health hazards of refineries during catastrophic failures and sufficient evidence of the health risks of air pollution from refineries during times of normal operation. Among the most populous US cities with the worst air pollution, Philadelphia has consistently been ranked in the top 10 (ALA, 2018). Closing the South Philadelphia refinery would remove one of the city's largest polluters, which may result in observable population health improvements (Burr et al., 2018), provided another hazardous industry and polluter does not take its place (CSB, 2019; PI & Maykuth, 2019a). Community engagement in the decision-making process for future use of the site, may lead to improved satisfaction with the ultimate plan (City Lab & Mock, 2015; Linkhart & National Civic League, 2019; Pennington & Corcoran, 2018).

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