Air Quality Monitoring in the Southeast Community in the City of Newport News, VA

Michala L. Hendrick, Department of Human Movement Sciences, Old Dominion University
Hueiwang Anna Jeng, School of Community and Environmental Health, Old Dominion University
Alexander M. Lasky, School of Community and Environmental Health, Old Dominion University
Ryan Mace, School of Community and Environmental Health, Old Dominion University

Abstract

Purpose: The objective of this study was to assess air quality in the Southeast Community of Newport News, VA by monitoring air pollutants, including $PM_{2.5}$, PM_{10}, VOCs, NO_2, and SO_2. Currently, there is a lack of community specified air quality data in Newport News despite observed environmental degradation and public health problems.

Methods: Three air sampling sites were located within residential areas of the Southeast Community, while four industrial air sampling sites were chosen based on proximity to potential pollution sources, including traffic emissions, the coal pier, and industrial activities. All of the industrial sites were located on the boundaries of the community. Each site was continuously monitored for eight hours per day and was sampled at least twice for data accuracy. A GRIMM PM monitor was used to measure $PM_{2.5}$ and PM_{10} and a MultiRae PRO (model PGM-6248) was used to continuously quantify VOCs, NO_2, and SO_2.

Results: While average $PM_{2.5}$ and PM_{10} from all sample sites were within the acceptable range of EPA air quality criteria, averaged VOCs in the industrial and highway areas were higher than those in the community.

Conclusion: The findings of this research suggest a need for long-term monitoring air quality with a series of air pollutants in the community.

Keywords: Air Quality Monitoring, Newport News Virginia, Air Pollutants, GRIMM, Environmental Public Health

Introduction

The Southeast Community in the City of Newport News, Virginia is four miles long and two miles wide. The community has a total population of 34,707, with greater than 78% being African American, and a disproportionately high number of citizens being of a low socioeconomic status (U.S. Census Bureau, 2010). Air quality is of high concern to residents, with asthma, heart disease and chronic lower-respiratory disease age-adjusted death rates being higher for African Americans in Newport News than in other areas of the Peninsula Health District and in the Commonwealth of Virginia (United States Environmental Protection Agency (US EPA), 2017a). The aforementioned public health concerns partially stem from local sources of contamination including increased traffic on highway I-664, shipyard facilities, coal terminals, and the Newport News Port (US EPA, 2017a).

Currently in the city of Newport News, seven out of 16 known industrial facilities operate in the Southeast Community. Two out of these seven industrial facilities have been operating in the Southeast Community since 1890 (Newport News Shipyard and Dry Dock Company) and one since 1892 (Coal Pier, now Dominion Terminal and Pier IX Terminal). These terminals house a ground storing capacity of 1.7 million tons of coal and a dumper with a dumping capacity of 5200 tons per hour (Dominion Terminal Associates, n.d.). Coal dust can spread into the surrounding environment from these sites during the transportation and storing of coal. Additionally, port operations, Interstate 664 traffic emissions, and local transportation are probable mobile sources of air pollutants for residents, including particulate matter (PM), nitrogen oxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), greenhouse gases, volatile organic compounds (VOCs), and metals. According to the most recent annual data available from 2013, of the toxic air emissions in the city, 72% occurred in the Southeast Community with more than 246,759 lbs. of toxic air released including 39,000 pounds of toluene, a known developmental toxicant (Sierra Club, 2020).

Despite environmental degradation from air pollutants, both mobile and point source, and disproportionately high rates of asthma, heart disease and chronic lower-respiratory disease, there is a lack of air quality data in the community. While the state is required to monitor air criteria pollutants, state monitors are not close enough to the community to provide air quality data that are community specific and relevant. The closest Department of Environmental Quality (DEQ) monitor tracking PM is located at the NASA Langley Research Center, more than 11 miles northeast of the community (Sierra Club, 2020). In order to fill the gaps of community specific data, the objective of this study was to monitor air quality in the Southeast Community by measuring air pollutants, including, $PM_{2.5}$, PM_{10}, VOCs, NO_2, and SO_2.

Methods and Materials

Sample locations

A total of seven sampling sites were selected (Table 1, Figure 1). Three sampling sites were designated *residential sites* (CA, CB, CC), and were selected to analyze residents' exposure to air pollution and obtain a representative spread of sites across the predominately residential housing area. Four sites were designated *industrial sites* (I1, I2, I3, I4), and sites I2, I3 and I4 were chosen based on their proximity to potential pollution sources, including the coal pier, Newport News Shipbuilding, and industrial activities (Figure 1). Site I1 was located closer to Highway I-664 in order to assess the impact of traffic emissions on air pollutants (Figure 1). All industrial sites were located on the outskirts of the predominately residential area (Figure 1). Specific sampling locations along with the latitude and longitude of each sampling site is provided in Table 1.

Table 1
Southeast Community Sampling Sites

Site code	Sampling location	Latitude	Longitude
	Residential		
CA	Jefferson Avenue & 21st Street	36.9781887	-76.4190854
CB	25th Street & Wickham Avenue	36.9846619	-76.4129986
CC	Orcutt Avenue & 32nd Street	36.9897629	-76.4142359
	Traffic		
I1	Marshall Avenue & 41st Street	36.9938189	-76.4220285
	Industry		
I2	19th Street & Terminal Avenue	36.9758576	-76.4210056
I3	900 Jefferson Avenue	36.9707913	-76.4140951
I4	Washington Avenue & 49th Street	36.9930610	-76.4396819

Figure 1
Sampling Sites in the Southeast Community of Newport News, VA

Note. Blue stars indicate community sampling sites; orange stars indicate industrial and traffic sampling areas.

Sampling strategy

Each site was continuously monitored for eight hours per day and each site was sampled at least twice (two days) for data accuracy. This ensured peaks and trends during hours of greatest business and social activity were captured in the data. To avoid the effect of rain on air pollutant concentrations, sampling only took place at least two days after rain events. Meteorological data, including ambient temperature, wind direction, and speed, were recorded during the sampling. Sampling was conducted between the days of Monday and Friday in the late summer and early fall.

A GRIMM PM (particulate matter) monitor was used to detect $PM_{2.5}$ and PM_{10}. The GRIMM monitor draws the air sample into a detection chamber where PM is classified and quantified by scattering light measurement. The particle size is proportional to the intensity of the reflected light beam. PM concentrations were determined from the particle count and the volumetric flow rate. Measurements were set at a 15-seconds interval. MultiRae PRO model PGM-6248 was used to continuously quantify VOCs (volatile organic compounds), NO_2 (nitrogen dioxide), and SO_2 (sulfur dioxide). This device uses PID photo ionization detectors, which meet EPA Method 21 compliance for the air pollutant detection, with detection limits of 10 ppb, 0.1 ppm, and 0.1 ppm for VOCs, NO_2, and SO_2, respectively. Each measurement was set at a 1-minute interval. Both devices were placed approximately 3 feet from ground level with the receiving valve of the instruments faced towards the road during sampling.

Quality control and assurance was conducted by following manufacturers' instructions. Each site monitoring session was recorded twice. Prior to daily sampling, the devices were calibrated according to manufacturer's recommendations. The machines were routinely checked during sampling to ensure correct operations. During monitoring, confounding factors such as nearby construction and lawn care were recorded in the field notebook. All of the readings were downloaded from the temporary memory of the devices to an excel sheet. Outliers were removed and all the data was laid out and presented as a times series to show a trend of PM. Mean and standard deviation were calculated for each pollutant. T-tests were utilized to measure for significance of pollutant measurements at the given locations.

Results

Particulate Matter (PM)

Figures 2-8 below display daily continuous measurements of PM_{10} and $PM_{2.5}$ for the seven sampling sites. As displayed in these figures, community PM concentrations fluctuated throughout the day with a stable trend. However, three sites located at the intersections of Marshall Avenue & 42nd Street, Washington Ave & 49th Street and Orcutt Ave & 32nd Street, had spikes of PM concentrations in the morning (7:30 am – 9:30 am) or in the afternoon (3:30 pm-5:30 pm).

As shown in Table 2, daily average PM_{10} concentrations for the community sites, including Jefferson Avenue & 21st Street (CA), 25th Street & Wickham Avenue (CB) and Orcutt Avenue & 32nd Street (CC), ranged from 10.86 µg/m^3 to 12.69µg/m^3, while average $PM_{2.5}$ concentrations ranged from 6.09 µg/m^3 to 10.87 µg/m^3 . The traffic site, Marshall Avenue & 41st St. (I1), saw an average PM_{10} concentration of 23.05 µg/m^3 and an average $PM_{2.5}$ concentration of 15.85 µg/ m^3. Daily average PM_{10} concentrations for the industrial sites, 19th St. & Terminal Ave (I2), 900 Jefferson Ave (I3) and Washington Avenue & 49th Street (I4), ranged from 9.18 µg/m^3 to 26.98 µg/m^3 while daily average $PM_{2.5}$ concentrations ranged from 4.87 µg/ m^3 to 17.74 µg/ m^3 (Table 2).

The highest daily average PM_{10} concentration of the seven sites (26.98 µg/ m^3) was recorded at the industrial site located on the intersection between Washington Avenue and 49th

Street (I4) and closest to the shipbuilding lot. The lowest daily average PM_{10} concentration (9.18 µg/ m^3) was recorded at the intersection between 19th St. & Terminal Avenue (I2) (Table 2). The highest daily average $PM_{2.5}$ concentration of the seven sites (17.74 µg/ m^3) was recorded at the site closet to the shipbuilding lot, while the lowest average $PM_{2.5}$ concentration (4.87 µg/ m^3) was recorded at 900 Jefferson Ave (I3), where a chemical operation complex is located. Both of the highest and lowest average PM_{10} and $PM_{2.5}$ concentrations were recorded at industrial sites (Table 2).

Volatile Organic Compounds (VOC)

The sampling sites in the community saw a range of daily average VOC concentrations from 19.15 ppb to 42.24 ppb. (Table 2). The traffic site, located at the intersection of Marshall Avenue & 41st St. (I1), saw a daily average VOC concentration of 268.8 ppb. The sites in the industrial area saw a range of daily average VOC concentrations from 32.23 ppb to 154.21 ppb (Table 2). The highest daily average VOC concentration of all sample sites was recorded at the traffic site, located at the intersection of Marshall Avenue & 41st St. (I1), with a measurement of 268.8 ppb (Table 2). In contrast, the lowest daily average VOC concentration was recorded at the community site located at the intersection of 25th St. & Wickham Ave (CB), with a value of 19.15 ppb (Table 2).

Nitrogen dioxide (NO_2) and Sulfur Dioxide (SO_2)

NO_2 and SO_2 were relatively stable with minute detection levels at the sample sites (Table 2). Of the community sites, the highest daily average NO_2 concentration was recorded at the intersection of Jefferson Avenue and 21st Street (CA) with a value of 0.04 ppm. The highest NO_2 concentration of industrial and traffic sites was recorded at both 900 Jefferson Ave (I3) as well as at the intersection of Marshall Avenue & 41st St. (I1) with a value of 0.15 ppm (Table 2).

Of the community sites, the highest average SO_2 concentration (0.15 ppm) was recorded at the intersection of 25th St. & Wickham Avenue (CB) (Table 2). The highest SO_2 concentration of the traffic and industrial sites were recorded at the intersections of 19th St. & Terminal Avenue (I2), 900 Jefferson Avenue (I3) and Washington Avenue & 49th Street (I4) with a value of 0.15 ppm (Table 2). The highest concentrations of NO_2 and SO_2 were both recorded at industrial sites.

Figure 2

Jefferson Avenue & 21st St. (CA)

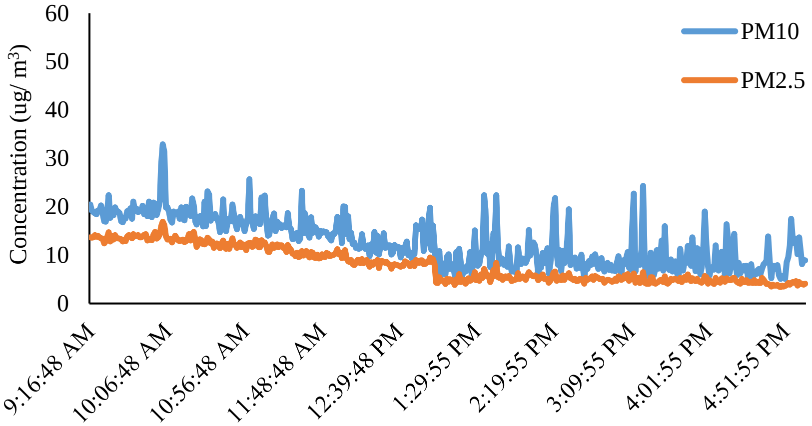

Figure 4

Orcutt Ave & 32nd St. (CC)

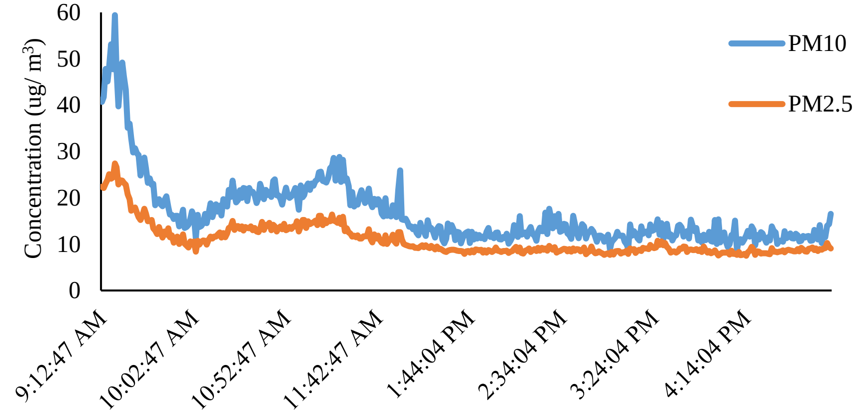

Figure 3

25th St. & Wickham Avenue (CB)

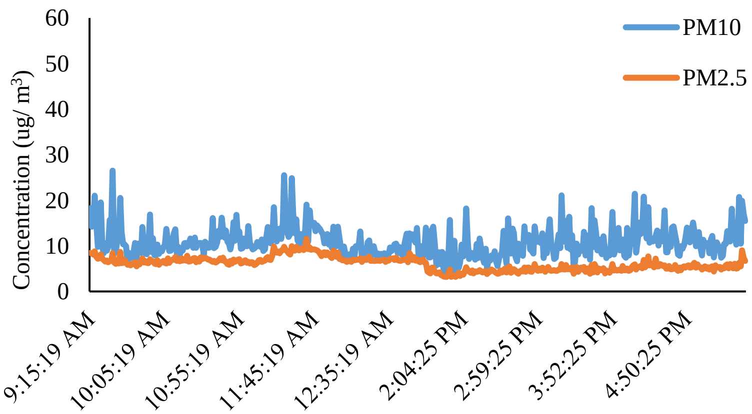

Figure 5

Marshall Ave & 41st (I1)

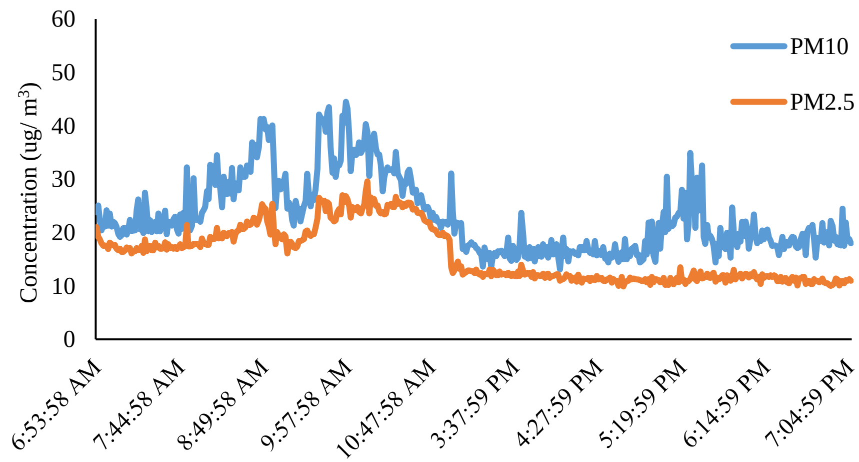

Figure 6

19th St. & Terminal Ave (I2)

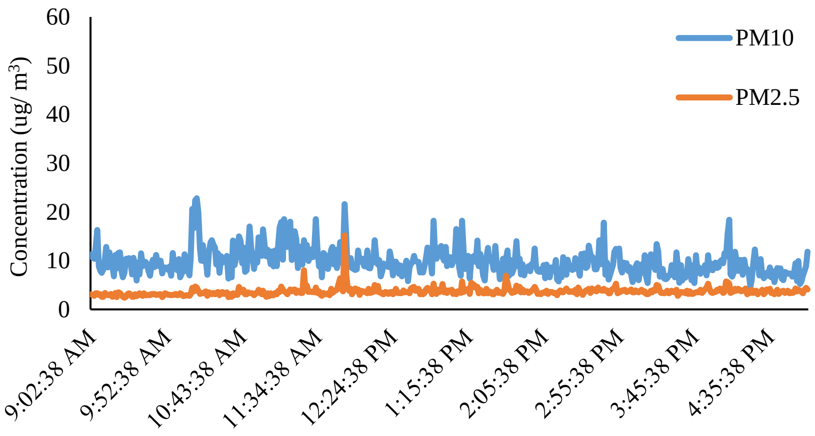

Figure 7

900 Jefferson Avenue (I3)

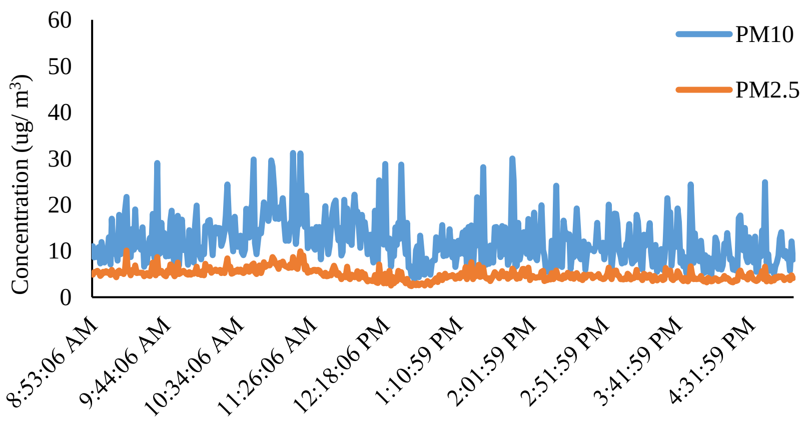

Figure 8

Washington Ave & 49th St (I4)

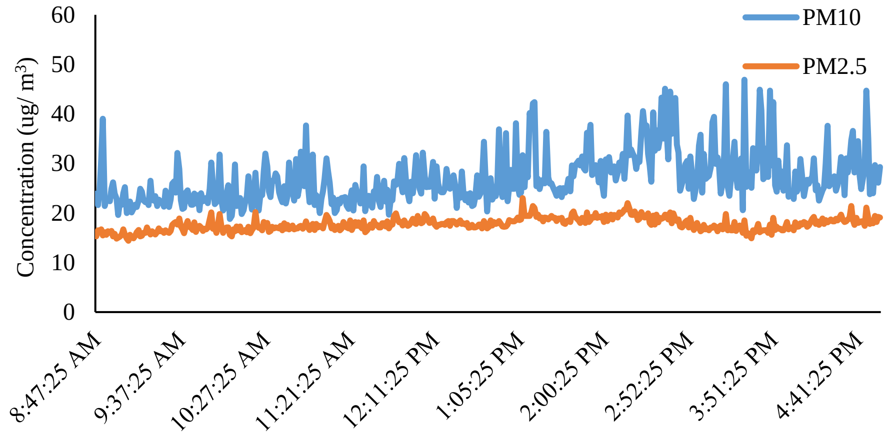

Table 2

Daily average concentrations of PM, VOC, NO_2 and SO_2 in the Southeast Community

Air Pollutant	Daily average	
	M	± SD
Jefferson Avenue & 21st Street (CA)		
PM10	12.69	5.03
PM2.5	7.99	3.59
VOC	26.12	47.96
NO_2	0.04	0.06
SO_2	0.06	1.36
25th Street & Wickham Avenue (CB)		
PM10	10.86	3.27
PM2.5	6.09	1.48
VOC	19.15	42.34
NO_2	0.03	0.22
SO_2	0.15	0.15
Orcutt Avenue & 32nd Street (CC)		
PM10	16.69	7.65
PM2.5	10.87	3.55
VOC	42.24	76.64
NO_2	0.001	0.01
SO_2	0.01	0.03
Marshall Avenue & 41st Street (I1)		
PM10	23.05	7.05
PM2.5	15.85	5.11
VOC	268.8	178.2
NO_2	0.15	0.15
SO_2	0.05	0.01
19th Street & Terminal Avenue (I2)		
PM10	9.18	3.21
PM2.5	5.70	0.92
VOC	154.21	243.3
NO_2	0.10	0.13
SO_2	0.15	0.15
900 Jefferson Avenue (I3)		
PM10	12.16	4.98
PM2.5	4.87	1.19
VOC	32.13	49.23
NO_2	0.15	0.15
SO_2	0.15	0.15

Air Pollutant	Daily Average M	± SD
Washington Avenue & 49th Street (I4)		
PM10	26.98	5.23
Air Pollutant	Daily Average M	± SD
PM2.5	17.74	1.29
VOC	45.92	54.32
NO_2	0.05	0.06
SO_2	0.15	0.15

Discussion

Environmental degradation has affected the Southeast Community of Newport News for decades stemming from toxic air emissions, especially those from electric utilities, ports, heavy traffic, coal terminals and industry (Sierra Club, 2020). Several studies have cited that exposure to $PM_{2.5}$ increases chance of cardiopulmonary problems and mortality due to lung cancer (Schwartz, 2000; Franklin et al., 2008). Additionally, VOC, while more of an exposure concern indoors, can cause photochemical smog under certain conditions outdoors, posing additional health concerns (US EPA, 2017b). This study is the first to record air quality monitoring results specific to the community. These results help provide baseline air quality readings for the community and a better understanding of the sources of observed environmental degradation.

Industrial activities and traffic emissions were possible pollution sources of VOCs, NO_2 and SO_2 in this community due to increased concentrations of air pollutants that were recorded at the sites adjacent to the ship building yard and Highway I-664. Both traffic and industrial emissions exhibited the greatest impact on air quality in the form of elevated VOC levels. Traffic emissions also attributed to elevated SO_2 and NO_2 concentrations.

The residential site of Orcutt Ave & 32nd Street was observed to have had higher VOC readings as compared to the other two residential sites. This site was located closest to the traffic site and two industrial sites as compared with other residential sites. Based on the weather records, wind may have transported VOCs from these traffic and industrial sites to the intersection of Orcutt Ave & 32^{nd} when sampling took place. In addition, a school was located three minutes from the sampling site where school buses may have contributed to the elevated VOC levels.

The trends of PM_{10} and $PM_{2.5}$ levels for most sampling sites remained stable. However, elevated trends and spikes in the morning and in the afternoon were observed at the traffic site (I1), which is the site closest to Highway 664. This suggests that traffic emissions from the highway may be attributed to increased PM levels. In addition, an elevated trend of PM at the residential site Orcutt Ave & 32^{nd} Street was observed. As mentioned previously, school buses in this area may have contributed to the elevated PM levels. Compared to VOCs, average PM concentrations were comparable among the residential, industrial and traffic sites. Average PM concentrations did not reflect impact from specific pollution sources. Based on the daily measurements, all recorded PM concentrations did not exceed EPA's criteria or the World Health Organization's recommended 25 $\mu g/m^3$ and 50 $\mu g/m^3$ 24-hour mean exposure limit for $PM_{2.5}$ and PM_{10} respectively (EPA, 2008; WHO, 2005). Due to the limited, short-term sampling period, future studies with robust data are needed for long-term monitoring to determine whether PM readings in the community meet the EPA's criteria.

The patterns observed in these recorded daily averages are not permanent but rather what was observed on the site during the individual sampling days. This data should be carefully interpreted and weighed against EPA standards which are calculated on a 30-day average as compared to daily averages, which can be impacted by fluctuations in temperature, weather and surrounding environmental conditions. Additionally, these sample sites may have seen a change in average traffic patterns that could skew daily averages and produce readings that are not representative of 30-day averages. Measuring PM only may not completely depict air quality status in the community. Future studies and research should incorporate more frequent and elongated sampling periods, with multiple air quality indicators, such as PM, VOC, NO_2 and SO_2 concentration readings for a robust data set. Additionally, this study did not include metals due to budget and time constrains; it is recommended future studies investigate metals in PM and soil.

Conclusion

Air quality data is important for community members who are concerned about environmental degradation due to air pollution as well as state and federal public health officials, who are tasked with identifying and addressing air quality related public health concerns in communities. These data will add to the expanding research surrounding air quality and pollution in the City of Newport News, Virginia. In this study, elevated concentrations of air pollutants, particularly VOCs, were observed. Industrial activities and traffic emissions may have attributed to the elevated concentrations of the air pollutants. While no EPA exceedances of PM was observed, NO_2 and SO_2 were detected at these data collection sites in the Southeast Community. It is recommended that air quality monitoring continue to gain a better understanding of air quality and contributing pollution sources, and to develop long term monitoring strategies for robust data.

References

Dominion Terminal Associates. (n.d.). *Dominion terminal associates LLP facility description. https://www.dominionterminal.com/?page_id=15151*

Franklin, M., Koutrakis, P., & Schwartz, J. (2008). The role of particle composition on the association between $PM_{2.5}$ and mortality. *Epidemiology (Cambridge, Mass.), 19*(5), 680–689.

Schwartz, J. (2000). Harvesting and long-term exposure effects in the relation between air pollution and mortality. *Am J Epidemiol, 151*(5), 440-448.

Sierra Club Virginal Chapter. (2020). *Giving a community a chance to breathe cleaner air.* https://www.sierraclub.org/virginia/york-river/blog/2020/01/giving-community-chance-breath-cleaner-air

United States Environmental Protection Agency. (2008). *National ambient air quality standards.* https://www.epa.gov/criteria-air-pollutants/naaqs-table

United States Environmental Protection Agency. (2017a). *A collaborative effort to assess environmental health in Newport News, Virginia*. https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=532162&Lab=NERL

United States Environmental Protection Agency. (2017). *Technical overview of volatile organic compounds.* https://www.epa.gov/indoor-air-quality-iaq/technical-overview-volatile-organic-compounds.

U.S. Census Bureau (2010). *Quickfacts. Newport News city, Virginia (County).* https://www.census.gov/quickfacts/fact/table/newportnewscityvirginiacounty/PST040219

World Health Organization (2005). *WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide.* https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf