Impact of Diesel Emissions from Port Facilities on Local Communities

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DELAWARE VALLEY REGIONAL PLANNING COMMISSION

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Table of Contents

Tables

Appendices

Executive Summary

This paper examines on-road emissions from diesel trucks that serve selected port facilities in the Greater Philadelphia region and identifies environmental justice issues impacting the communities that host port facilities. Generally, the communities surrounding ports exhibit higher rates of poverty, host larger minority populations, and have higher rates of respiratory and cardiovascular disease and poorer health outcomes than the region at large. The health outcomes in communities surrounding ports are exacerbated by the concentration of diesel engine emissions from marine vessels visiting the ports, equipment used to offload the vessels, and trucks and locomotives that transport goods from the ports to the larger region and beyond.

In an attempt to quantify on-road diesel emissions from Heavy-duty Vehicles (HDV) serving the ports, DVRPC utilized existing vehicle class and traffic counts on seven National Highway System (NHS) connectors to model the emissions from HDVs (trucks weighing more than 16,001 lbs., or vehicle classes 5, 6, 7, and, 8 Gross Vehicle Weight Rating) on roadways serving port facilities using the MOVES 2010 emissions model. From that analysis, emissions were calculated for Class 8 vehicles to demonstrate the benefits of programs that would facilitate updating the fleet of HDVs visiting port facilities in the region. This analysis strategy was chosen because the data on HDV counts was readily available, and these trucks travel through the communities adjacent to port facilities.

Air quality modeling analysis shows that emissions rates for Volatile Organic Compounds (VOCs), Nitrogen Oxides (NO_x), and fine particulate matter ($PM_{2.5}$) for the groups of HDVs traveling on these NHS connectors that are model year (MY) 2007 or later are between 83 and 95 percent lower than the emissions rates for the pre-2007 MY trucks in that same fleet. The difference in emissions rates for the Class 8 HDVs is even greater, with emissions rates for the post-MY 2007 fleet of trucks being between 88 and 96 percent lower than the pre-MY 2007 HDVs traveling on these seven NHS connectors.

Other ports in the Mid-Atlantic region have piloted programs to mitigate emissions from diesel sources, including HDV replacement programs. This paper includes a survey of these activities at ports in the Mid-Atlantic region. The paper recommends adoption of funding strategies to spur action to reduce the environmental and public health impact of goods movement in and through the communities surrounding port facilities.

Beginning in 2017, the Port Authority of New York and New Jersey (PANYNJ) will implement a ban on pre-MY 2007 diesel trucks. This ban has the potential to create a secondary market for older trucks to serve the ports in the Greater Philadelphia region. As demonstrated, pre-MY 2007 vehicles can emit up to 90 percent more NO_x and $PM_{2.5}$ into the surrounding communities than post-MY 2007 trucks. While such a ban may not be immediately feasible in this region, efforts to encourage fleet turnover and emissions reduction strategies are prudent to protect public health and air quality and to help ports in the region keep pace with the ongoing sustainability efforts of other ports in the nation.

Reliable and accessible funding sources, along with technical assistance from federal, state, and local agencies to help port and truck fleet operators access funding for diesel equipment repowers and retrofits are critical components to addressing emissions from diesel engines at port facilities. The other critical component is identifying industry partners. Since funding for diesel emission reduction projects is very limited, public–private partnerships geared toward mitigating diesel emissions in the Greater Philadelphia

region will be necessary to raise awareness and create momentum to address this issue and improve air quality in the region's most vulnerable communities and in the region as a whole.

This paper provides a limited view of the baseline emissions from selected NHS connectors in the region but highlights the potential benefits of proactive programs to facilitate diesel fleet turnover in the region. Conversely, this study demonstrates the potential harm to air quality should the region become a receiving area for older model year HDVs that are banned from visiting other ports along the East Coast.

Introduction

Ports play a critical role in the economic health of the Greater Philadelphia region. As trends in goods movement point toward globalization, ports increasingly serve as the gateway for materials into and out of the nation and the region. These trends put pressure on the transportation infrastructure required to effectively move goods and services but also on the environment and communities that host these ports and transportation infrastructure.

Goods movement activities, generally, and port operations, particularly, rely on diesel-powered equipment to move cargo. Diesel engines are a powerful, efficient, and proven technology well suited to this task. Unfortunately, older diesel engines (pre-model year 2007) are also a major source of air pollutants, such as fine particle pollution ($PM_{2.5}$) and precursor emissions that contribute to ozone pollution, such as nitrogen oxides ($NO_{x)}$ and volatile organic compounds (VOCs). The Delaware Valley Regional Planning Commission (DVRPC) region has recently (January 2015) been redesignated as meeting the 1997 and 2006 $PM_{2.5}$ air quality standards and, with the exception of Delaware County, meets the 2012 $PM_{2.5}$ standards. The entire region does not meet the federal air quality standards for ground-level ozone. Ozone and $PM_{2.5}$ pollution are implicated in respiratory disease, cardiovascular disease, and even premature death. The impact of ambient air pollution is amplified in environmental justice (EJ) communities where lack of access to health care, balanced diet, and exercise, and even increased levels of daily stress, result in poorer health outcomes for the residents of those communities.

Certain EJ communities are in close proximity to port facilities where diesel emissions from marine engines, port cargo handling equipment, and HDVs that transport cargo to and from the ports are concentrated. Ports across the nation, including ports in the Mid-Atlantic region, have begun instituting efforts to reduce the environmental impact of cargo handling operations, including efforts targeted at reducing diesel emissions from both on-road and off-road sources.

In 2014, the U.S. Environmental Protection Agency (EPA) kicked off a National Ports Initiative. The goals of the initiative are to implement strategies to encourage environmental progress at ports; reduce climate risk; support operational and technological improvements to increase efficiency; improve community health and air quality; and to encourage sustainable economic development that supports the economy and jobs. Through the initiative, the EPA is working with stakeholders to share best practices and coordinate efforts to further the initiative's goals.

Ports in the Greater Philadelphia region have been slow to adopt sustainability measures that are being implemented at other East Coast ports, but opportunities exist for ports in the region to adopt best practices that have been piloted by ports in peer cities. Funding, although limited, is available at the federal, state, and regional levels that can be accessed to address environmental sustainability at the region's goods movement centers. In order to maintain economic competitiveness and to be good neighbors and valued corporate citizens, the goods movement community, regulators, funding sources, and communities must work cooperatively to address diesel emissions in the region's vulnerable communities.

Demographics around Ports

The DVRPC region is home to 31 marine ports along the Delaware River, located in seven counties including Bucks, Delaware, and Philadelphia in Pennsylvania and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. U.S. Census data shows that communities surrounding ports tend to be EJ communities that are also economically disadvantaged. According to the American Community Survey (ACS) data profile from 2009–2013, the average median household income at the tract level for the nine-county DVRPC region was $68,109, while the average median household income in the seven counties that contain ports average $62,566. There is a much larger disparity when analyzing those tracts that are within a half-mile vicinity of ports. The median household income drops significantly in tracts within 0.5 miles from ports to an average of $47,809. This is 30 percent less than the nine DVRPC counties and 23.5 percent less than the seven counties that host port facilities. Other indicators, such as the percentage of families below the federal poverty level ($23,550 per year for a family of four), percentage of households on the Supplemental Nutritional Assistance Program (SNAP), and unemployment rates, all indicate that neighborhoods in closer proximity to ports have increased economic disadvantages (Table 1).

Table 1: Selected Demographic Statistics for the DVRPC Region and Census Tracts Near Port Facilities

Demographic	Nine-county DVRPC Region	DVRPC Counties with Port Facilities	Tracts within 0.5 Mile of Ports
Median Household Income	$68,109	$62,556	$47,809
Percent of Families below Poverty	12%	14%	18%
Percent Receiving SNAP Benefits	11.7%	13.8%	21%

Source: American Community Survey 2009–2013

DVRPC has created a measurement of analysis to track Indicators of Potential Disadvantage (IPD) at the census tract level. The individual IPD categories are non-Hispanic minority, Hispanic minority, car-less households, households in poverty, female head of household with child, elderly (over 75 years), limited English proficiency, and persons with a physical disability. The IPDs were created to provide standardized measures that indicate where populations of disadvantaged people may live in the region. Each IPD has a threshold percentage, above which indicates that the census tract in question has a higher than average share of persons meeting that criteria. Each census tract in the region can then be scored based on the number of IPDs present in the tract. Generally, the more IPDs present in a census tract, the greater the potential economic disadvantages experienced by the population of that census tract. For more information on the DVRPC IPD methodology, please visit **www.dvrpc.org/webmaps/ej2014**.

The median IPD score for the nine-county region equals 2.7 IPDs compared to 3.1 for those counties that contain ports, and 4.1 for those tracts that are within 0.5 miles of ports. Many of the disaggregated IPD statistics show that concentrations of disadvantaged populations live in proximity to port facilities (Table 2).

Table 2: Indicators of Potential Disadvantage (IPD)Characteristics of the Region and Census Tracts Hosting Port Facilities

IPD	Nine-county DVRPC Region	DVRPC Counties with Port Facilities	Tracts within 0.5 Mile of Ports
Average IPD Score	2.7	3.1	4.1
Non-Hispanic Minority	28%	32%	29.4%
Car-less Households	15%	18%	22%
Female Head of Household w/ Child	9%	10.1%	13.7%
Elderly (over 75)	6.8%	6.7%	6.5%
Percent Hispanic Minority	7.9%	8.8%	12.2%
Limited English Proficiency	3%	3.3%	3.6%
Persons with Physical Disability	11.8%	12.8%	15%

Source: DVRPC Indicators of Potential Disadvantage—Disaggregated Statistics 2015

While port facilities are frequently located near economically disadvantaged communities, these facilities are important economic generators for host communities and the region. According to the FHWA's Freight Analysis Framework (FAF) database, approximately $15 billion worth of freight was imported to and exported from the Philadelphia Combined Statistical Area (CSA) by water, presumably through the Delaware River ports, in 2012. Port facilities directly employ thousands of workers in the region, in addition to creating jobs in industries that distribute freight as well as companies that provide infrastructure and support services for goods movement.

Health and Air Pollution

According to the EPA, nationally, one in ten ports are located in areas that do not meet the federal air quality standards, and many border EJ communities (EPA 2015a). Based on the socioeconomic data and DVRPC IPD methodology, this assertion holds true for the communities surrounding ports in the Greater Philadelphia region. The combination of economic disadvantages, ambient air quality that does not meet the federal health-based standards, particularly during the summer months, and concentration of diesel emissions associated with ports and goods movement operations make the EJ communities surrounding port facilities particularly susceptible to health impacts associated with poor air quality.

Diesel emissions are a major source of $PM_{2.5}$, NO_x, and VOCs. According to the most recent report from the EPA on air emissions trends, $PM_{2.5}$ emissions from all mobile sources are approximately 19.4 percent of the national total of direct $PM_{2.5}$ emissions, with 6.5 percent coming from on-road sources (EPA 2011). NO_x emissions from mobile sources account for approximately 41 percent of the national total, with 24.5 percent coming from on-road sources. Approximately one-third of on-road mobile emissions of $PM_{2.5}$ and one-quarter of the NO_x emissions are from HDVs (EPA 2015b). These numbers represent a significant source of emissions whose health impacts are compounded for people living, working, and playing in proximity to the sources of these emissions.

Ozone exposure has been implicated in premature death, chronic respiratory disease, and decreased lung development and function. Short-term exposure can aggravate respiratory conditions, promote lung infections, and result in increased hospitalization in response to respiratory distress (American Lung Association 2014).

$PM_{2.5}$ pollution is a suspected carcinogen and has both long-term and short-term exposure implications that are aggravated by both the pollutant concentrations and duration of exposure to the pollutant. Fine particles get trapped deep in the lungs and can trigger respiratory distress as well as cause premature death. Even short-term exposure has been linked to strokes, increased heart attacks, inflammation of lung tissue, and increased mortality in infants and young children. Groups that face the greatest risk of harm from particle pollution include infants, children, and teens; people over 65; people who work or are active outdoors; people with low incomes; and people with lung disease, heart disease, or diabetes. While diabetics face increased risk due to their higher risk for cardiovascular disease, some studies suggest that air pollution itself can be a risk factor for diabetes (American Lung Association 2014).

In 2010, DVRPC acquired data on health topics through the Public Health Management Corporation (PHMC). PHMC surveys 10,000 households every two years to provide information on a broad range of self-reported health topics, including health status, access and use of health care services, and personal health behaviors in the five DVRPC counties in Pennsylvania. This data was collected in 2010 and disseminated in 2012. Of the data collected, DVRPC selected four health-related indicators to account for persons with asthma, diabetes, overweight and obesity, and high blood pressure. The data was disaggregated by age (children under 18, adults, and adults over age 60). The data shows that populations in ZIP codes within a half mile of port facilities have greater instances of all four indicators, with one exception (Elderly Obese and Overweight), than the counties where they are located and the Pennsylvania portion of the region as a whole. Table 3 details the selected health statistics from PHMC.

These health indicators were chosen because they are markers of general wellness, and evidence links $PM_{2.5}$ pollution with asthma, heart disease, and diabetes. Instances of asthma have a well-established relationship with exposure to air pollution, and studies indicate that obesity may exacerbate the relationship between $PM_{2.5}$ exposure and incidences of diabetes and heart disease (Environmental Health Perspectives 2014). It is a generally accepted concept that health outcomes in EJ communities are influenced by a complex set of factors and can be aggravated by exposure to air pollution.

It is important to note here that the health data presented from the PHMC Community Health Database is the best available data available at the time of the writing of this paper. There are statistical limitations with this dataset, including the fact that the health conditions are self-reported and that there may be limited numbers of respondents in any given ZIP code. The health data is, however, consistent with expectations for EJ communities and demographic data for these communities.

Table 3: Selected Health Statistics for ZIP Codes within 0.5 mile of Port Facilities in Southeastern Pennsylvania

	Five PA Counties	Three Port Counties (PA)	ZIP Codes within 0.5 Mile of Ports
Diabetes (% in ZIP Code)			
Adult	12.8%	13.5%	15.0%
Elderly (60+)	24.0%	24.0%	28.5%
Asthma (% in ZIP Code)			
Adult	15.5%	16.0%	17.8%
Elderly (60+)	17%	16.5%	21.7%
Child	23.0%	24.6%	25.1%
High Blood Pressure (% in ZIP Code)			
Adult	35.9%	38.5%	40.8%
Elderly (60+)	57.5%	59.6%	60.3%
Obese and Overweight (% in ZIP Code)			
Adult	63.2%	65.6%	65.3%
Elderly (60+)	63.9%	65.2%	41.6%
Child	33.8%	38.4%	42.4%

Source: Public Health Management Corporation, Community Health Database (PA Counties) 2012, DVRPC

Air Quality and Freight Movement

Data shows that air quality in the DVRPC region is improving. In 2015, the region was redesignated as attaining the 1997 and 2006 $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS). The region still does not meet the 2008 Ozone NAAQS, and in 2015, Delaware County was designated a nonattainment area (NAA) for the 2012 $PM_{2.5}$ NAAQS.

While regional ambient air quality is showing signs of improvement, as seen by the air quality monitoring network, freight and goods movement projections indicate that populations living in proximity to these centers of activity in the Greater Philadelphia region may be subjected to higher levels of local-level emissions that will impact the community’s health. Numerous studies indicate that proximity matters when considering the impact of emissions on community health.

The total number of marine vessels that have entered Delaware River ports has been increasing since the economic recovery began in 2010. Marine vessels are often one of the largest sources of diesel emissions at port facilities due to the amount and type of diesel fuel used. As a comparison, ocean-going vessels account for 51 percent of $PM_{2.5}$ emissions at the port of Los Angeles and 64 percent of $PM_{2.5}$ emissions at the Port Authority of New York/New Jersey (Diesel Technology Forum 2015).

The annual summary of cargo and Piers data provided by the Maritime Exchange for the Delaware River and Bay includes cumulative and monthly totals of marine vessels entering all Delaware River ports (including the state of Delaware). From 2012 to 2013, the ports have seen an increase of 62 vessels. While totals may fluctuate due to the competitive nature of the industry, from 2010–2013 there has been a net increase of 110 marine vessels (Table 4).

Table 4: Monthly Totals of Marine Vessels in Delaware River Port Facilities, 2010–2013

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
2010	164	154	205	170	180	153	155	171	160	161	174	181	2028
2011	207	185	207	196	189	184	172	182	169	174	161	157	2183
2012	185	177	191	183	159	161	175	150	167	155	185	188	2076
2013	194	173	212	189	178	166	174	171	166	174	167	174	2138

Source: Maritime Exchange for the Delaware River and Bay 2015

Freight movement is also expected to grow in tonnage within the Philadelphia PA-NJ-DE-MD Combined Statistical Area (CSA) for both truck and water according to the FHWA's FAF. The FAF is a tool that integrates data from multiple sources to create a comprehensive picture of freight flow movement among states and major metropolitan areas by all modes of transportation (FHWA 2015a). Based on these projections, truck freight tonnage is expected to grow 19 percent, and water freight tonnage is expected to grow 17 percent from 2015 to 2040 in the Philadelphia CSA (Table 5). Diesel emissions from HDVs are a significant portion of total port emissions accounting for eight percent of $PM_{2.5}$ emissions at the Port of Los Angeles and 11 percent of $PM_{2.5}$ emissions at the Port of New York/New Jersey. It can be assumed that the vast majority of the tonnage arriving in the CSA by water is entering through one of the Delaware River ports and transferred onto rail or truck.

With freight tonnage projected to grow within the region, much of the cargo will flow through ports and other large-scale goods movement centers. The growth in both truck and water freight tonnage has the potential to increase both congestion and vehicle idling at port facilities and on the National Highway System (NHS) connectors that serve these facilities. Idling has been shown to be a significant source of diesel emissions, and NHS connectors often traverse the EJ communities surrounding the port facilities.

Table 5: Freight Projections for Philadelphia CSA (2015–2040)

Destination	Mode	Total Tons in 2015 (,000s)		Destination	Mode	Total Tons in 2020 (,000s)
Philadelphia PA-NJ-DE-MD CSA	Truck	142,712.79		Philadelphia PA-NJ-DE-MD CSA	Truck	153,330.67
Philadelphia PA-NJ-DE-MD CSA	Water	15,097.17		Philadelphia PA-NJ-DE-MD CSA	Water	16,264.50
Philadelphia PA-NJ-DE-MD CSA	Rail	9,296.88		Philadelphia PA-NJ-DE-MD CSA	Rail	10,160.02
Destination	**Mode**	**Total Tons in 2030 (,000s)**		**Destination**	**Mode**	**Total Tons in 2040 (,000s)**
Philadelphia PA-NJ-DE-MD CSA	Truck	159,823.48		Philadelphia PA-NJ-DE-MD CSA	Truck	169,598.54
Philadelphia PA-NJ-DE-MD CSA	Water	17,217.56		Philadelphia PA-NJ-DE-MD CSA	Water	17,635.58
Philadelphia PA-NJ-DE-MD CSA	Rail	11,441.61		Philadelphia PA-NJ-DE-MD CSA	Rail	12,324.57

Source: Freight Analysis Framework—Water and Truck Freight Tonnage Projections PA-NJ-DE-MD CSA 2015–2040

Regulations on Diesel Engines

Although regulations for diesel vehicles were enacted as early as 1974, rules that significantly reduced NO_x and $PM_{2.5}$ emissions were not implemented until the mid-2000s. Regulations generally took two forms; regulations on fuels and regulations on engines. Much of the technology that removes NO_x and direct $PM_{2.5}$ from the exhaust of the engine requires low levels of sulfur in the diesel fuel to function properly. Sulfur in fuels interferes with the catalytic process that reduces $PM_{2.5}$ emissions, and sulfur compounds also serve as $PM_{2.5}$ precursors when emitted. This situation required that low sulfur fuels be widely available before the implementation of advanced emissions controls on diesel engines.

EPA regulations requiring ultra-low sulfur diesel (ULSD) fuel, with less than 15 parts per million of sulfur, for on-road engines were phased in between 2006 and 2010. Lower sulfur fuel regulations for marine and non-road engines were phased in between 2007 and 2014. Significant emissions reductions from on-road diesel engines were required for model year (MY) 2007 and MY 2010 diesel engines. Reductions from non-road and marine engines are being phased in between 2008 and 2015 based on the size of the engine.

These regulations are expected to reduce $PM_{2.5}$ emissions from HDV vehicles, marine diesel engines, and non-road diesel engines by 90 percent and NO_x emissions by 95 percent from the older diesel engines.

ULSD fuels have provided immediate air quality benefits for the region. Emissions benefits from new diesel engines will take longer to realize as fleet turnover to replace older diesel engines will take years, if not decades.

MOVES Emissions Modeling

Developing emissions inventories from port facilities is a complicated and expensive endeavor. In a complex environment, like the Greater Philadelphia region, where 31 different port facilities are spread over more than 55 miles of river with various owners and facility operators, a comprehensive emissions inventory from the ports goods movement sector becomes exponentially more complex and is beyond the scope and timeframe of this paper. Moreover, neither the Pennsylvania Department of Environmental Protection (DEP) nor the New Jersey DEP publish detailed emissions inventories for port facilities in their respective states.

DVRPC staff modeled emissions from HDVs (vehicles greater than 16,001 lbs. or vehicles classes 5, 6, 7, and 8) on NHS connectors serving port facilities in an attempt to characterize the on-road emissions attributable to port facilities in the region, using readily available data, and viewing the results through the framework of mitigation efforts already being implemented by peer ports in the Mid-Atlantic region. From the analysis of emissions from HDVs, staff extracted the emissions of the Class 8 (>33,001 lbs.) vehicles. Class 8 HDVs are the typical “tractor trailers,” and over 99.8 percent of Class 8 trucks are diesel powered, and these vehicles are typically the group that is targeted for replacement in peer port programs to reduce goods movement emissions.

For this analysis, DVRPC identified NHS connectors to port facilities where truck classification counts have been conducted in the past five years. NHS connectors are defined as key roads that connect intermodal facilities to the NHS, which provide the vital first and last mile that trucks travel when taking goods to or from an intermodal facility (DVRPC 2007). The assumption is that a large portion of the trucks accessing these connectors are serving port facilities within close proximity. The connectors represent the closest point of contact with the local community.

Emissions from HDVs on the NHS connectors were then simulated with the EPA’s Motor Vehicle Emissions Simulator 2010 (MOVES). MOVES is an emissions modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria pollutants, greenhouse gases, and air toxics (EPA 2014).

For this analysis, the truck classes from the counts were categorized into MOVES vehicle types (single unit short haul, single unit long haul, combination short haul, and combination long haul vehicles) and connector characteristics, including number of lanes and average speeds, and were input to the MOVES model. Model outputs were set to provide $NO_{x,}$ VOC, $PM_{2.5}$, and CO_2 emissions for a July day. The pollutants were selected based on the health impacts of direct $PM_{2.5}$ and the ozone formation potential of NO_x and VOCs. A July day was chosen because July is the height of the ozone season, and that is when these pollutants would have the greatest impact on air quality in the area. Results from the model for all heavy-duty trucks that are Class 5 and greater (>16,001 lbs.) are presented to demonstrate the magnitude of emissions from HDVs serving the port facilities. The results from the analysis of emissions attributable to Class 8 vehicles (in this case, the combination short haul and combination long haul vehicles) were extracted from the results to demonstrate the potential benefits of a heavy-duty diesel vehicle replacement program like those that have been successfully implemented at peer ports on the East Coast.

Data is not available for the total emissions from port facilities in the regions. Therefore, it is not possible to calculate the percentage of emissions from port facilities that originate with HDVs, but this analysis does point to effective mitigation measures that can be implemented following examples set by the Port Authority of New York/New Jersey, Port of Baltimore, and Port of Virginia. Focusing on on-road HDVs has the co-benefit of focusing on sources of diesel emissions that travel through the communities around the port facilities and that have a direct impact on the surrounding communities.

Analysis Results

Before exploring the results of the air quality modeling, it is important to reiterate that this was a modeling exercise based on vehicle class counts at particular locations on roadways serving ports in the region. Vehicle age from state vehicle registration data, VMT, and emission characteristics of the vehicles are products of the model input and output files and are based on data provided by the respective state departments of transportation. Emissions from all of the HDVs, as well as disaggregated data from Class 8 vehicles, are reported. The emissions from the Class 8 vehicles account for approximately 60 percent of the NO_x and $PM_{2.5}$ emissions while accounting for only 36 percent of the vehicles.

A total of seven NHS connectors and ten truck classification counter locations that serve access to port facilities were identified, including three counters at the Philadelphia International Airport connector, two counters at the Penn Terminal connector, and one counter each at Tioga Marine Terminal, Crowley Petty's Island, CSX Transflo, Port of Bucks, and South Philadelphia Freight Terminal. Counts were conducted in 2013 for Penn Terminal, PHL, CSX Transflo, and South Philly Freight Terminal, while the remaining counts range from 2011–2012.

Model emission outputs were aggregated by model year (MY) of the trucks (provided by MOVES outputs). Outputs were then compared for emissions from groups of HDVs based on MY. MYs for the analysis of various age-groups of trucks were selected based on regulations at peer ports prohibiting trucks older than MY 2004 and future regulations banning trucks older than MY 2007. These comparisons demonstrate the air quality benefits of programs to encourage fleet turnover for HDVs visiting the port facilities.

Using MOVES model outputs, the emissions profiles of different aggregated age groups and sizes of trucks were compared to each other. Emissions from MY 2004–2015 (post-2003) trucks were compared to emissions from MY 1985–2003 (pre-2004) trucks and emissions from MY 2007–2015 (post-2006) trucks were compared to emissions from MY1985–2006 (pre-2007) trucks for all vehicles classes. The comparison was also repeated for just the Class 8 vehicles, According to the model outputs, emissions for NOx, $PM_{2.5}$, and VOCs saw a significant decrease between the age groups of trucks even though the distance traveled in miles on the modeled facilities was higher for the newer vehicles (Tables 6 and 7). Table 6 details the daily NO_x, $PM_{2.5}$, and VOC emissions and miles traveled on the selected NHS connectors from four age groups of vehicles (emissions from the group MYs 1985–2003 compared to MYs 2004–2015, and emissions from the group MYs 1985–2006 compared to MYs 2007–2015) for all vehicle classes, and Table 7 presents the same data set for the Class 8 vehicles. These tables demonstrate the emissions improvements that can be attributed to modernizing the HDV fleet visiting the region's ports.

Table 6: Comparison of Emissions (Grams per Day) between Groups of Vehicles Based on Model Year (All Vehicle Classes)

Age of Vehicles	Number of Vehicles in Age Group	Emissions (grams per day)			Truck Miles Traveled on Connector
		NO_x (g/d)	$PM_{2.5}$ (g/d)	VOC (g/d)	
All Vehicle Classes					
Pre-2004 (MY1985–2003)	1,314	86,416.1	5,393.1	7,816.9	6,641.7
Post-2003 (MY2004–2015)	2,358	32,626.8	2,966.8	4,034.2	12,170.4
Percent Change	79.5%	–62.2%	–45.0%	–48.4%	83.2%
Pre-2007 (MY1985–2006)	1,828	102,443.4	6,824.4	10,075.9	9,238.2
Post-2006 (MY2007–2015)	1,844	16,961.4	376.9	1,407.8	9,318.0
Percent Change	0.9%	-83.4%	-94.5%	-86.0%	0.8%

Source: DVRPC 2015

Table 7: Comparison of Emissions (Grams per Day) between Groups of Vehicles Based on Model Year (Class 8 Vehicles Only)

Age of Vehicles	Number of Vehicles in Age Group	Emissions (grams per day)			Truck Miles Traveled on Connector
		NO_x (g/d)	$PM_{2.5}$ (g/d)	VOC (g/d)	
Class 8 GVWR Vehicles Only					
Pre-2004 (MY1985–2003)	507	57,156.1	3,630.9	2,603.6	2,526.4
Post-2003 (MY2004–2015)	829	16,165.0	1,105.4	1,005.7	4,129.2
Percent Change	63.5%	–71.7%	–69.6%	–61.4%	63.4%
Pre-2007 (MY1985–2006)	693	63,840.5	4,320.7	3,174.2	3,253.3
Post-2006 (MY2007–2015)	642	7,467.6	198.2	249.9	3,197.8
Percent Change	–7.4%	–88.3%	–95.4%	–92.1%	–1.7%

Source: DVRPC 2015

The distance traveled by an age group of vehicles is a function of the number of HDVs in the group. The length of the connectors remained unchanged in each analysis. Additionally, when all vehicle classes were considered, there were 1,044 more trucks in the post-2003 vehicle age group than the pre-2004 group. Outputs show a decrease of 62 percent for NO_x emissions, 45 percent decrease for $PM_{2.5}$, and 48 percent decrease for VOCs, while miles traveled between the groups of vehicles increased by 83 percent (Table 6). When only the larger Class 8 vehicles were considered, there were 322 more trucks in the post-2003 vehicle age group compared to the pre-2004 group. Outputs show a decrease of 72 percent for NO_x emissions, 70 percent decrease for $PM_{2.5}$, and 61 percent decrease for VOCs, while miles traveled between the groups of vehicles increased by 63 percent.

MOVES model analysis indicates that the difference between emissions between the group of pre-2007 HDVs and post-2006 HDVs is even greater, even though the miles attributable to those vehicles are approximately the same. Analysis shows a decrease of 83 percent for NO_x emissions, 94 percent decrease in $PM_{2.5}$, and 86 percent decrease in VOCs from the pre-2007 vehicle age group to the post-2006 vehicle age group when all vehicle classes are considered. The number of miles traveled was nearly identical, with miles totaling 9,238 miles in the pre-2007 age group and 9,318 miles for the post-2006 age group. When only the Class 8 vehicles are considered, analysis shows a decrease of 88 percent for NO_x emissions, 95 percent decrease in $PM_{2.5}$, and 92 percent decrease in VOCs from the pre-2007 vehicle age group to the post-2006 vehicle age group, while the distance traveled by the cohort of newer trucks was only 56 miles or 1.7 percent less in the newer age group.

The difference in emissions improvements between all vehicle classes and just the Class 8 trucks is a factor of the number of trucks and also that approximately 32 percent of Class 5, 6, and 7 trucks are gasoline powered and have different emissions profiles than diesel trucks, while almost 100 percent (>99.8%) of the Class 8 trucks are diesel powered. This difference is demonstrated in Table 7, which details the emissions rates for each pollutant from the different vehicle classes and age groups. As expected, the emissions results demonstrated in Tables 6 and 7 indicate greater emissions reductions by replacing the larger diesel engines.

Table 8: Emissions Rate Reductions for Four Age Groups of HDDVs

Average Emissions Rates					Average Emissions Rates			
All Vehicle Classes								
Age Groups HDDVs	Pre-2004	Post-2003	Percent Reduction		Age Groups HDDVs	Pre-2007	Post-2006	Percent Reduction
NOx (g/m)	13.01	2.68	79.4%		NOx (g/m)	11.09	1.82	83.6%
PM2.5 (g/m)	0.81	0.24	70.4%		PM2.5 (g/m)	0.74	0.04	95.0%
VOC (g/m)	1.18	0.33	72.0%		VOC (g/m)	1.09	0.15	86.2%
Class 8 Vehicles Only								
Age Groups HDDVs	Pre-2004	Post-2003	Percent Reduction		Age Groups HDDVs	Pre-2007	Post-2006	Percent Reduction
NOx (g/m)	22.62	3.91	82.7%		NOx (g/m)	19.62	2.34	88.1%
PM2.5 (g/m)	1.44	0.27	81.2%		PM2.5 (g/m)	1.33	0.06	95.5%
VOC (g/m)	1.03	0.24	76.7%		VOC (g/m)	0.98	0.08	91.8%

Source: DVRPC 2015

Since vehicle replacement programs typically focus on the larger diesel engines, typified by the Class 8 vehicles, DVRPC calculated the approximate emissions reductions that would result in modernizing the Class 8 vehicle fleet. MOVES model analysis showed that an approximate total of 45,371 grams of NOx, 3,434 grams of $PM_{2.5}$, and 2,356 grams of VOCs can be reduced per day from these seven NHS connectors if Class 8 trucks with MY 2003 engines and older could be retrofitted or replaced with vehicles meeting the MY 2007 diesel engine standards. Furthermore, approximately 53,072 grams of NOx, 10,498 grams of $PM_{2.5}$, and 2,858 grams of VOC can be reduced per day from these seven NHS connectors if Class 8 truck engines MY2006 and older would be subject to replacement with engines meeting the MY 2007 standard. It is important to note that while the number of trucks and miles traveled are increasing in later years, model outputs still show substantial reductions in emissions.

This analysis accounts for only a very small fraction of emissions attributable to port operations in the region and provides estimated values for one day. Yet the emissions from these seven road segments serving port facilities equals approximately 0.25 percent of the total on-road mobile source NO_x emissions and 0.55 percent of the $PM_{2.5}$ emissions for a July day for the entire five-county Pennsylvania portion of the DVRPC region, while representing only 0.02 percent of the miles traveled from all of the highway segments in those five counties for one day (based on the FY2013 PA TIP Conformity analysis). While a straight conversion to emissions per year is not a valid exercise based on the seasonal nature of the port operations, projections to one year’s worth of emissions would highlight considerably more benefits to mitigating diesel emissions from on-road sources.

Funding Programs and Peer City Initiatives

Recognizing the scope of the impacts of diesel emissions from port operations and goods movement, the federal government has funded a number of initiatives to assist port and goods movement operators to replace or retrofit aging diesel equipment. Ports in the Mid-Atlantic region (Baltimore, Port of Virginia, and Port Authority of New York and New Jersey (PANYNJ)) have accessed these funds and created local initiatives to improve air quality in their respective regions.

Funding Sources

In 2008, the EPA established the National Clean Diesel Campaign (NCDC). The NCDC is funded through the Diesel Emissions Reduction Act (DERA), which appropriated money to promote the reduction of diesel emissions throughout the country. Since that time, the program has funded nearly 60,000 pieces of clean diesel technology.

In 2014, the EPA awarded $5 million in order to improve air quality at ports. Recipients that were awarded grant money include the City of Los Angeles Harbor Department, New Jersey Department of Environmental Protection, Oregon Department of Environmental Quality, and the Port of Houston Authority. Public port authorities or state and local government agencies with jurisdiction over transportation or air quality are eligible for funding. Other stakeholders such as shippers, carriers, terminal operators, and community groups must work in coordination with these eligible applicants in order to receive funding. Eligible equipment includes diesel vehicles and engines, including drayage trucks; marine vessels; locomotives, and non-road engines, equipment, or vehicles used in the handling of cargo at the marine port. An EPA Ports Initiative funding round has not been announced for 2015.

States also get an allocation of DERA funds to hold statewide competitive funding rounds to replace or retrofit diesel equipment. In 2015, Pennsylvania held a funding round to distribute $1.7 million for diesel projects. Awards for this funding have not yet been announced. The state of New Jersey operates an active “Stop the Soot” program geared specifically at addressing emissions from diesel engines. The Stop the Soot program has distributed approximately $10 million statewide for diesel reductions projects since 2008.

The Congestion Mitigation and Air Quality (CMAQ) program is an additional funding source that can be used to improve air quality around the Greater Philadelphia region ports. CMAQ is a jointly administered program by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) that provides a flexible funding source for transportation projects and programs that help improve air quality and reduce congestion. "State and local governments can use the funding to support efforts to meet National Ambient Air Quality Standards (NAAQS) under the Clean Air Act in both nonattainment and maintenance areas for carbon monoxide, ozone, and particulate matter" (FHWA 2015c). Additionally, Moving Ahead for Progress in the 21st Century (MAP-21) requires states with designated nonattainment or maintenance areas for $PM_{2.5}$ to use a portion of CMAQ funds for projects to reduce $PM_{2.5}$ emissions (FHWA 2015c).

The SmartWay Program is a public–private initiative between federal and state agencies, trucking companies, rail carriers, logistic companies, commercial manufacturers, and retailers that looks to improve fuel efficiency and reduce the environmental impact of the goods movement supply chains (EPA 2015d). SmartWay aims to accelerate the availability, adoption, and market penetration of advanced fuel-efficient technologies and operational practices in the freight supply chain, while helping companies save fuel, lower costs, and reduce adverse environmental impact. EPA helps SmartWay Partners move more goods, more miles, with lower emissions, and less energy through financing and technical assistance tools.

Peer Port Initiatives

The PANYNJ became a leader of environmental sustainability among East Coast ports by initiating their first 10-year Clean Air Strategy (CAS) in 2009. The CAS aimed to achieve an overall decrease in port-related emissions regardless of any port growth within those 10 years. The three main objectives include reducing emissions-related impacts on human health and environment with a focus on diesel particulate emissions; reducing greenhouse gas (GHG) emissions associated with climate change; and helping the NY-NJ-Long Island Nonattainment Area attain the NAAQS. While the full impact of the CAS implementation has yet to be analyzed, early results yield encouraging impacts based on the 2010 NY/NJ Ports emissions inventory. The latest 2010 Port Authority of New York and New Jersey Port Commerce Department Emissions Inventory released in December 2012 show that pollutants decreased at a rate greater than or equal to the annual three percent goal set in the CAS, despite a 4.2 percent increase in cargo volume at the ports during those four years (CAS 2013, ES-1). Since then, the Port Authority has implemented more strategies to improve air quality, such as disallowing port drayage trucks with 1993 Model Year engines and older from going into their ports. Starting in 2017, restrictions will become even greater as the Port Authority will deny access to trucks that do not meet or exceed model year 2007 federal emission standards. As previously mentioned, the port facilities in the Philadelphia region are owned and operated by a number of different agencies and private companies, as opposed to PANYNJ which has a level of jurisdiction over unified port facilities in New York City and Northern New Jersey. This lack of a unified port in the Philadelphia region makes a truck ban at port facilities in the Philadelphia region more difficult to implement

These restrictions would not have been possible without supplemental programs, such as the Trucks Replacement Program, which was established to replace trucks that had MY 2003 engines or older with newer EPA emissions-compliant engines. Eligibility requirements include "independent owner-operators or licensed motor carriers that owned port drayage trucks with engines Model Year 2003 and older that frequently served the port, and who agreed to continue to service the port with the replacement truck for five years" (CAS 2013). From 2010 to 2013, the truck replacement program used federal grant money to scrap 429 old diesel trucks and replaced them with new clean diesel and fuel-efficient trucks. Eligible applicants were able to receive grants that covered up to 25 percent of the purchase price of a new truck, as well as low interest financing on the remaining 75 percent (PANYNJ 2013). Funding from the program was received through the American Recovery Reinvestment Act, National Clean Diesel Funding Assistance Program, as well as Port Authority operating funds, while financing options were made possible under the EPA's SmartWay Program through which PANYNJ received $750,000. In November 2014, PANYNJ was approved for two million dollars through a CMAQ grant that will help assist their new 2017 restriction standards for trucks MY 2007 or older. This grant will cover up to 50 percent for replacing trucks, a 25 percent increase from the previous funding amount.

The Port of Baltimore implemented a Drayage Truck Replacement Program starting in February 2012. Trucks must have a model engine year between 1990 and 2003 and must be replaced with trucks that have MY2010 or newer engines to qualify for the program. Funding for the program was provided by the EPA, Maryland Port Administration, Maryland Department of Transportation, and Maryland Department of Environment. In April 2014, the EPA provided additional funds from the DERA grant program to continue to help replace drayage trucks. From February 2012 through May 2014, the program has replaced 82 drayage trucks (VCC 2015).

The Port of Virginia launched its Green Operators (GO) program in 2009 with funding provided by the United States Department of Energy and the Virginia Department of Environmental Quality. This public–private program managed by the Virginia Port Authority, Virginia Clean Cities (VCC), and the Mid-Atlantic Regional Air Management Association (MARAMA) enables applicants to receive up to $20,000 toward the purchase of a newer vehicle that meets or exceeds MY 2007 EPA emissions standards. Eligible trucks must have a MY 2003 engine or older, while preference is given to trucks with MY1997 engines or older. The program also offers retrofits for truck engines from 2002–2006. Applicants are able to receive 100 percent, or up to $6,000, in rebate funds. To date, the program has replaced or retrofitted 8 percent of the 2,700 trucks that operate at the port, a three percent increase above their original goal (MPA 2015).

Local Initiatives

Within the Greater Philadelphia area, the Philadelphia Diesel Difference (PDD) working group was created in order to help build a partnership with stakeholders interested in reducing air pollution from diesel engines through voluntary programs and use of innovative strategies. One of these strategies includes helping secure financial support from grants that reduce diesel emissions for partners and stakeholders involved within the working group. PDD works with the Philadelphia Clean Air Council (CAC) to apply for funding to mitigate diesel emissions. PDD and CAC have successfully completed DERA funded diesel replacement projects in that past.

PDD and the CAC worked cooperatively with MARAMA to expand its $3.9 million dollar Mid-Atlantic Green Operator Program to include ports in Philadelphia and Wilmington. The Green Operator was originally intended for Virginia and Baltimore ports, and the program was created in order to help replace older drayage trucks to reduce air pollution. The program was funded primarily through the EPA and ran from July 2010 through June 2014. Eligible applicants were able to receive up to $20,000 to be used in order to purchase clean engine trucks that have MY2007 engines or newer. Despite industry support for the program, MARAMA found it difficult to find additional funding for the Philadelphia-Wilmington area (MARAMA 2014).

In 2012, DVRPC held a $10 million competitive CMAQ funding round, which made funds available for port projects and diesel replacements and retrofits, among other project types. Two diesel locomotives were successfully repowered through this program for $2 million, and one port diesel equipment repower project was awarded funds ($300,000) but not implemented. In 2015, DVRPC has made $3.6 million available for funding a competitive CMAQ program for projects in Burlington, Camden, Gloucester, and Mercer counties. In October, 2015, the DVRPC Board approved using $1 million of these funds to support the replacement of 13 diesel forklifts at the Balzano Marine Terminal in Camden, New Jersey. These funding sources are eligible as the basis of a trucks replacement program that would supplement a clean air strategy for ports within the region.

Conclusion

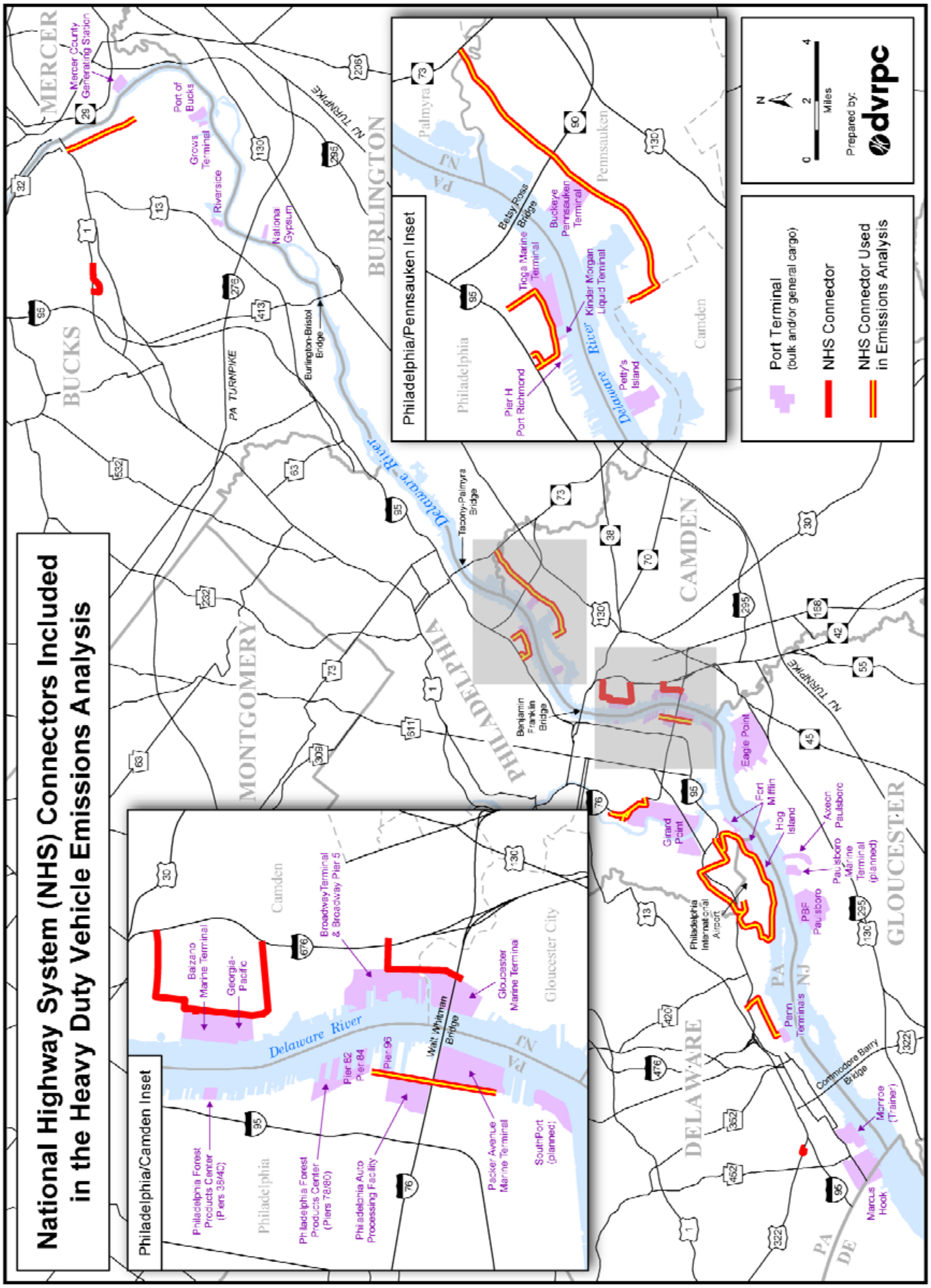
Demographic data shows that the communities surrounding port facilities in the Greater Philadelphia region are more economically disadvantaged than the region at large, and the residents of these neighborhoods are more susceptible to the poor health outcomes associated with chronic exposure to air pollution. The concentration of diesel engines, both on- and off-road, related to goods movement and port operations in the region can raise the exposure of surrounding communities to higher concentrations of harmful emissions. This situation is not unique to the Greater Philadelphia region, and similar conditions are well documented at ports in cities across the nation.

Ports in this region are falling behind other ports in the Mid-Atlantic region and in the nation in implementing projects to mitigate the impacts of diesel emissions from their operations on the surrounding communities. Beginning in 2017, PANYNJ will implement a ban on pre-MY 2007 diesel trucks. This ban has the potential to create a secondary market for older trucks to serve the ports in the Greater Philadelphia region. As demonstrated, pre-MY 2007 vehicles can emit up to 90 percent more NO_x and $PM_{2.5}$ into the surrounding communities. While such a ban may not be immediately feasible in this region, efforts to encourage fleet turnover and emissions reduction strategies are prudent to protect public health and air quality and to help ports in the region keep pace with the ongoing sustainability efforts of other ports in the nation.

Reliable and accessible funding sources, along with technical assistance from the PDD, DVRPC, New Jersey DEP, EPA Clean Ports Initiative, and MARAMA to help port and truck fleet operators access funding for diesel equipment repowers and retrofits are critical components to addressing emissions from diesel engines at port facilities. The other critical component is identifying industry partners. Since funding for diesel emission reduction projects is very limited, public–private partnerships geared toward mitigating diesel emissions in the Greater Philadelphia region will be necessary to raise awareness and create momentum to address this issue and improve air quality in the region's most vulnerable communities and in the region as a whole.

DVRPC is uniquely positioned, as both a source of potential funding and a convening entity for industry and public agencies through the Goods Movement and Healthy Communities Task Forces, to raise awareness and facilitate the necessary partnerships to address diesel emissions and improve air quality in the region. Actions such as competitive CMAQ funding rounds that encourage diesel emissions reduction projects at ports and good movement centers can create a momentum around this issue while creating nontraditional partnerships that can benefit both the goods movement community and the region as a whole.

Appendix A: Map of NHS Connectors in the Heavy-duty Diesel Vehicle Emissions Analysis



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Geographic Area Covered:

The nine-county DVRPC planning area, which covers the counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey.

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Abstract:

The Delaware Valley Regional Planning Commission (DVRPC) examined the demographics of communities surrounding port communities in the region and reviewed existing health statistics for these communities. Demographic and health data analysis shows that communities surrounding port facilities are generally more economically disadvantaged than the region as a whole. DVRPC analyzed air emissions from heavy-duty vehicles on National Highway System (NHS) Connectors that serve port facilities in these communities where existing vehicle class counts were available. The emissions analysis revealed that older (pre-model year 2007 trucks) are responsible for the majority of emissions from heavy-duty vehicles serving the port facilities, and efforts to modernize the fleet of vehicles serving the ports has the potential to improve air quality in these neighborhoods and the larger region.

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