Mitigating Air Quality Impacts in Newport News, Virginia

Modeling Future Air Emissions, Identifying Community Health Effects, and Proposing Multilevel Solutions

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I. ABSTRACT

Located on the southeastern end of the Virginia peninsula in the Hampton Roads metropolitan area, Newport News, Virginia is closely tied to the maritime shipping and military industries. Through a partnership with the Environmental Protection Agency and community organizations, eight UNC-Chapel Hill undergraduate students analyzed air quality and health concerns related to the movement of freight and other industrial activities in the city. In a meeting with Newport News community members on March 31, community members expressed an interest in learning more about Newport News Shipbuilding, the Asheville-Schoonmaker Mica Company, and plans for widening Interstate 664 in addition to port operations. Of particular concern were the potential health-related impacts of the industrial activities in the community. GIS and the Community Port or Roadway Traffic (C-PORT) tool, a web based tool that generates projected spatial data for pollutant concentrations based on dispersion models, were used to model the emissions from port-related activities to better understand the air quality in the region. Based on the model results, potential solutions were proposed to mitigate health effects related to port operations and other industrial-source stressors. Individual/interpersonal, community, and state/federal solutions were investigated and provided. These solutions have revealed the importance of academic and community partnerships with federal involvement for addressing issues related to air quality in Newport News, VA.

II. NEWPORT NEWS BACKGROUND INFORMATION

Founded in 1896, Newport News, Virginia is known for international commerce, shipbuilding, and technological research. In 1958, Warwick and Newport News merged into what is now the city of Newport News. Newport News played an important role in World War II. During the war, 1.5 million soldiers traveled through Newport News and surrounding areas. The civilian population increased by 77.2 percent during the war because the shipyards needed employees to build military ships (Newport News, 2015). Newport News was a major
shipbuilding hub before the war and remains a major shipbuilding hub today because Newport News Shipbuilding, the major shipbuilder in the area, has $4 billion in revenues.

**Marine Terminals**

Newport News' proximity to water makes it an ideal location for marine terminals. In 1952, the Virginia Port Authority (VPA) was founded to oversee business in the Port of Virginia. The VPA acquired port terminals in Newport News, Portsmouth, and Norfolk in the early 1970s (McCabe, 2012). In 2014, 63 percent of the cargo that came into the Port of Virginia was transported via truck, 33 percent was transported via rail, and 4 percent was transferred via barges (Virginia Port Authority, 2014). There are four major ports in or around Newport News: the Newport News Marine Terminal, Norfolk International Terminals, Portsmouth Marine Terminal, and Virginia International Gateway. Additionally, Craney Island is currently being expanded and converted into a port terminal. After this expansion, it will have a major impact on Newport News, as well.

The Newport News Marine Terminal (NNMT) is the VPA’s “main break-bulk and roll-on/roll-off facility.” NNMT has an “on-dock rail service” for CSX Corporation, a rail and intermodal transportation business, so materials that are shipped into NNMT can be directly placed onto CSX containers. Additionally, NNMT has the capability to transfer goods and raw materials from CSX to Norfolk Southern, a different rail and intermodal transportation business, in Richmond (Virginia Port Authority, 2015).

Meanwhile, Norfolk International Terminals (NIT) is the largest terminal the VPA controls. NIT is comprised of three parts: the South Terminal, the North Terminal, and the Central Rail Yard. Railways at NIT can travel directly to Norfolk Southern’s Heartland Corridor and access Midwest markets. Currently, “Thousands of daily truck moves are processed through 17 interchange lanes and two on-terminal transfer zones,” and the terminal is almost at full capacity. However, “future plans call for an expansion of up to 26 interchange lanes” (Virginia Port Authority, 2015).
Portsmouth Marine Terminal (PMT) can process “containers, break-bulk, and roll-on/roll-off cargo.” PMT has the ability to service both CSX and Norfolk Southern. CSX containers move on railways connected directly to the facility; meanwhile, cargo is transported on Norfolk Southern containers via the Norfolk Portsmouth Beltline Railway (Virginia Port Authority, 2015).

Virginia International Gateway (VIG) is “the largest privately-owned container terminal in the United States.” In July 2010, the VPA and VIG entered into an agreement under which the VPA would control VIG for 20 years. Despite its remarkable size, the VIG is almost at capacity. VIG is also “one of the only functional automated container terminals in the Western Hemisphere.” However, VIG is not fully automated; rather, it is a combination of automated and manual equipment. VIG serves both CSX and Norfolk Southern through the Commonwealth Railway (Virginia Port Authority, 2015).

Craney Island Expansion

Craney Island is also located in the Port of Virginia. The Virginia Port Authority (VPA) and the U.S. Army Corps of Engineers (USACE) are working together to expand the island by 522 acres. The Craney Island Eastward Expansion Project intends to increase the amount of dredged material that the Craney Island Dredged Material Management Area (CIDMMA) can hold, because the CIDMMA is expected to reach capacity in 2025 (U.S. Army Corps, Crist, 2012). It will also create a space to build a fifth marine terminal in the area. The VPA and USACE began planning this expansion in 2007 and began constructing the dike in 2010. The eastward expansion is expected to be completed in 2022. However, the marine terminal construction will not be completed until around 2038. Overall, the Craney Island Eastward Expansion Project is expected to create over 54,000 jobs, many of which are indirectly related to the expansion. Additionally, the project is expected to generate $1.7 billion in yearly wages and $155 million in yearly state and local tax revenue (Crist, 2012). This terminal will be semi-automated and have the ability to manage 50 percent of the terminal’s container volume by railway. Moreover, the terminal will service both CSX and Norfolk Southern because the
“Commonwealth Rail Line will be extended from State Route 164 to Craney Island through a project known as the Port of Virginia Gateway” (Virginia Port Authority, 2015).

**Panama Canal Expansion**

The Panama Canal is currently being expanded and is set to open in April 2016. The project was originally supposed to be completed in October 2014, but a number of delays have pushed the completion date back (Jervis, 2015 and O’Neal, 2014). After the $5.25 billion expansion, ships carrying up to 14,000 containers will be able to pass through the canal (Jervis, 2015). Presently, Panamax container ships are about 945 feet long. After the Panama Canal Expansion, ships will be an average of 1,400 feet long and 60 feet deep—enabling them to carry more goods (O’Neal, 2015). Ultimately, this expansion is expected to increase the amount of cargo entering the Port of Virginia, but the specific amount of cargo is unknown.

**Demographics**

The demographics in Newport News, Virginia vary significantly from the Commonwealth of Virginia as a whole. In 2013, the city had a population of 182,015 people, 41.2 percent of which was black or African American, substantially higher than the 19.7 percent figure for the Commonwealth of Virginia. Moreover, only 23.9 percent of Newport News residents have obtained a bachelor’s degree or higher, well below the commonwealth level of 35.2 percent. Additionally, 15.2 percent of the population is below the poverty level, slightly above the commonwealth level of 11.3 percent (United States Census Bureau, 2015). The burden on certain demographic groups is important in the analysis of environmental pollution in Newport News, VA.

**III. STRESSORS OF INTEREST**

**Newport News Shipbuilding**

While Newport News Shipbuilding built military ships during World War II, the company builds both military and commercial ships today. Founded in 1886 and originally named the Chesapeake and Dry Dock Construction Co., the company is a division of Huntington Ingalls
Industries. The company’s shipyard is located along 2.5 miles of the James River. Newport News Shipbuilding is the only builder of U.S. navy aircraft carriers, one of two builders of U.S. Navy submarines, and the largest shipbuilder in the U.S (Huntington Ingalls Industries, 2015).

Newport News Shipbuilding has a major impact on the Newport News community, especially with regards to employment. The company is the largest industrial employer in Virginia, employing more than 23,400 people (Huntington Ingalls Industries, 2015). Most of these employees are third and fourth generation shipbuilders (Newport News Shipbuilding, 2015). Moreover, the company has more than 2,000 suppliers, nearly half of which are small businesses. Each year, Newport News Shipbuilding spends about $1 billion on supplies (Huntington Ingalls Industries, 2015). In addition to employing many Virginia residents and keeping small businesses running, the company is boosting the local economy. As of March 12, finishing touches were being added to the Gerald R. Ford aircraft carrier that Newport News Shipbuilding constructed. This carrier is expected to contribute between $100 and $125 million to Newport News’ economy. Specifically, the 2,600-member crew will receive salaries and benefits, and there will be profitable maintenance and service contracts for the Gerald R. Ford aircraft carrier (Lessig, 2015).

Despite its importance to the Newport News economy, a Sierra Club report deemed the shipbuilding giant the largest emitter of toxic chemicals in Newport News (Sierra Club, 2014). Risk Screening Environmental Indicators (RSEI) indicate that Newport News Shipbuilding released 152,935 pounds of toxic chemicals in 2011, well above the U.S. median value 16,476 pounds (Environmental Protection Agency).

Moving forward, the company is building its own health center. In the fall of 2015, Huntington Ingalls Industries will open the Newport News Family Health Center, a health center for employees at Newport News Shipbuilding and their dependents (Huntington Ingalls Industries, 2015). This center will not be open to unionized employees, but it will provide non-
unionized employees with primary care, laboratory services, and will include an on-site pharmacy (Site Selected, 2015).

**Asheville-Schoonmaker Mica Co.**

In the 1940s, the Asheville Mica Co., A.O. Schoonmaker, and the Mica Company of Canada merged to form the Asheville-Schoonmaker Mica Co. After merging, the newly formed company moved to its current Newport News location. Mica minerals can resist heat and electricity. Thus, the company’s products are used in “small appliances, strip heaters, tubular heaters, high voltage transformers, traction and D.C. motors, grid resistors, thermal batteries and electronics” (Asheville-Schoonmaker Mica Company). The Asheville-Schoonmaker Mica Co. uses benzene as a solvent in Mica production. When used in mica production, benzene turns into toluene. The Toxic Release Inventory (TRI) report reveals that the mica plant released 91,272 pounds of toluene. Also, 1,177 people live within three miles of the Asheville-Schoonmaker Mica Co., and 85 percent of these people are minorities (Mica Company of Canada, 2015).

**Interstate 664**

Virginia Interstate 664 (I-664) comprises the western half of the Hampton Roads Beltway System, a 56-mile loop that connects all Hampton Roads cities. I-664 extends nearly 21 miles through Hampton, Newport News, Suffolk, and Chesapeake. It runs from the eastern end of Interstate 64 upward toward the James River. I-664 includes the Monitor-Merrimac Memorial Bridge Tunnel and enters Newport News before it rejoins I-64, the eastern half of the Hampton Roads Beltway System. The interstate was built between 1981 and 1992, starting with its extension of I-64 in Newport News and ending with the opening of the 4.6-mile Monitor-Merrimac Memorial Bridge-Tunnel (Kozel, 2003). Several ports in the Port of Virginia use I-664 to transport containers that arrive at their locations. The Newport News Marine Terminal, Portsmouth Marine Terminal, and Virginia International Gateway have trucks moving consistently on I-664 (Virginia Port Authority, 2015).
Given the expected increase in cargo by 2040, due to the expansion of the Panama Canal and the construction of Craney Island, the amount of trucks on I-664 will increase. While congestion can lead to accidents and delays, congestion is also an issue because emissions from vehicles are concentrated over time. Moreover, truck emissions are higher at slower speeds, so congestion can have negative impacts on truck emissions. As of now, around 8 percent of vehicles on I-664 are trucks (Virginia Department of Transportation, 2012).

Recently, the Virginia Department of Transportation proposed a new project called the "Hampton Roads Third Crossing" as a way to decrease regional congestion. I-664 currently has six lanes for the northern segment upward from 35th street in Newport News and four lanes from 35th street to US-58 in Chesapeake, with 8 lanes for the last mile until it reconnects with I-664 (Kozel, 2003). In 1997, the Commonwealth Transportation Board reviewed several propositions for the Hampton Roads Third Crossing Project and chose Corridor 9. This option entails: a widening of I-664 in Newport News to eight lanes; a construction of two new tubes parallel to the Monitor-Merrimac Memorial Bridge-Tunnel; a construction of an additional bridge-tunnel structure from the Monitor-Merrimac Memorial Bridge-Tunnel near Naval Station Norfolk; an addition of a new four-lane highway connector from the new bridge to the Western Freeway in Portsmouth, which will be known as the Craney Island Connector; and a widening of I-664 to six lanes from the Monitor-Merrimac Memorial Bridge-Tunnel to the Bowers Hill interchange. The benefits of this Hampton Roads Third Crossing project include greater total mobility; reduced congestion; and improved access to port terminals, Newport News Shipbuilding, and marine and naval facilities. The anticipated cost is $4.32 billion. As of July 2005, $39.4 million of the project will come from federal funding, and a public-private partnership is being considered to cover the rest of the costs (Virginia Department of Transportation, 2012).

The Port of Virginia is making additional changes to mitigate the impacts of its trucks. Specifically, the Port of Virginia has a Green Operator Program to retrofit and/or replace trucks manufactured before 2007 engines that meet EPA standards. Thus far, the Green Operator
Program has attended to over 400 trucks, reducing NOₓ, CO, VOC, SO₂, and PM 2.5 emissions by as much as 25 percent (Virginia Port Authority, 2015).

IV. METHODS

In order to evaluate the air quality in Newport News, Virginia, we analyzed a collection of spatial data that included port terminals, Class I and II shipping channels, Class III shipping channels, boilers, and rail yards. Each original shapefile was carefully investigated in GIS to ensure our data was up-to-date. The data was then entered into a web tool known as C-PORT, an interactive software developed by the EPA, which uses dispersion algorithms to generate a raster prediction of concentrations of chemicals emitted from various sources.

Port terminal polygon shapefiles were developed by the UNC Institute for the Environment and based on point data provided by the U.S. Army Corps of Engineers. Prior to modifying the port terminal shapefile, Bing satellite imagery was used to identify the locations and sizes of all port terminals of interest, namely Newport News Marine Terminal, Norfolk International Terminal, Portsmouth Marine Terminal, and Virginia International Gateway Terminal. A polygon representing Craney Island Marine Terminal was also created based on satellite imagery, as well as the Port of Virginia’s Future of Newport News Environmental Presentation, and was drawn into the study area along with the four established port terminals (Virginia Sustainable Building Network, 2010). The polygons were improved to more accurately represent the real areas by editing vertices using the Generalize tool with a resolution of 100 meters and the editor tool. Using the Generate Near Table tool with the National Weather Service’s point shapefile of all weather stations, each polygon was joined to its closest weather station to ensure that C-PORT uses the best meteorological parameters. Lastly, each polygon was spatially joined with a county. From the port terminal shapefile, a new shapefile called the ships at dock point shapefile was generated. Each point was created along the edge of the port terminal polygon adjacent to the water to represent the point where a ship is most likely to do to
load or unload cargo. Weather station data and county data was joined in the same manner as the port terminal shapefile for the ships at dock shapefiles.

The original boiler point shapefile was created using data from the National Emissions Inventory (NEI). This shapefile contained all boiler data for the entire U.S. The original boiler shapefile was clipped by the port terminal shapefile, creating a new shapefile of only boilers within port terminals. Weather stations and county data were joined using the same procedure as the ships at dock point shapefile and port terminal polygon shapefiles.

Originally, the railyard data provided by the NEI contained only points over railyards. With the railyard point shapefile overlaid atop Bing maps satellite imagery, a polygon was created around the original railyard point. Data from the original NEI point shapefile was then joined to the new polygon shapefiles.

Shipping lane data was originally provided by the Oak Ridge National Laboratory (ORNL), Vanderbilt University, and the U.S. Army Corps of Engineers. The original data had all shipping data for the U.S., but only used line segments that were within eight miles of the coastline were used. Line segments, leading from the open ocean to each terminal were selected using the Select tool and then saved to a new shapefile. Using the Summary Statistics tool, a table containing the total emissions along a route leading to each terminal was generated. All shipping lane shapefiles created were then merged into one line shapefile. Emissions data was then joined to this shapefile. A value, $\beta$, was calculated based on the ratio of emissions to the number of ships multiplied by the length. Each line was given a concentration value based on the equation below:

$$Total\ Emissions = \beta \times \sum_{All\ Terminals} \ (Activity \ (tons\ of\ cargo) \times PathLength \ (meters))$$

The new GIS data was then added to C-PORT, an interactive tool that determines areas with elevated concentrations based on port sources of chemical emissions. Using C-PORT, one can generate data for different scenarios based on seasonality, time of data, and chemical of
concern. All variables in the model can be modified to represent a “what-if” scenario for the port community. The variables available in C-PORT are meteorological conditions, season, day, hour, pollutant, area sources, point sources, rail sources, road sources, and ship-in-transit sources. Within each variable, emissions can be directly changed in the scenario or influential factors of emissions can be changed, i.e.: the speed limit on the roads. For this analysis, all scenarios modeled Winter in AM peak during weekdays under stable conditions. The five chemicals evaluated were NOx, CO, PM$_{2.5}$, EC$_{2.5}$, and benzene. Comma-separated values (CSV) files containing location and chemical concentration were generated for each scenario as well as a baseline. The CSV files were then converted to an XLSX file, and concentration values were converted into logarithmic values by using the log10 calculation. The concentration values were plotted as points in Lambert Conformal Conic projections in GIS. Using the Kriging tool, concentration values were interpolated from the individual points to the entire study area to identify locations where concentrations may be of most concern. The data for each was overlaid for each scenario with the baseline for comparison. After analyzing these, new maps were generated that would compare the difference between the hypothetical concentrations and the actual concentrations. This was the procedure for determining areas of concern of harmful chemical concentrations in Newport News, Virginia.

**Data Changes for the Widening of I-664 Scenario**

In order to better understand the air quality effects that would occur with the Hampton Roads Third Crossing project and related I-664 expansion, C-PORT conditions were changed for the segment of I-664 from east of the Newport News Shipbuilding Company to south of Craney Island. For this scenario, only the road variables in C-PORT were modified to represent an increase in trucks as a result of the interstate widening. All other variables remained at the baseline levels. As the Hampton Roads Third Crossing project will increase I-664 from six to eight lanes, the Annual Average Daily Transit (AADT) number, which is the number of vehicles that pass through each day, was increased by a factor of 1.33. The volume of traffic typically
increases in proportion to the increase in road capacity (Duranton and Turner, 2011, p. 2639). Additionally, as I-664 widens and capacity increases, more diesel trucks from the Newport News Marine Terminal, Virginia International Gateway and later Craney Island will be enticed to use the highway. To represent this increase, the number of diesel trucks was also increased by a factor of 1.33. The miles per hour of the segment remained the same.

**Data Changes for the Craney Island Expansion Scenario**

While running baseline scenarios, the emissions data attributed to the original polygon was set to zero for all pollutants due to the fact that the Craney Island terminal is not yet finished. With the construction of Craney Island, the Port of Virginia foresees the new terminal to have a five million twenty-foot equivalent unit (TEU) capacity. TEU is a barometer used to measure cargo capacity. Craney Island emission values were based on Norfolk International Terminal (NIT) emissions, as NIT is closest in size to that proposed for Craney Island. As such, the terminal’s pollutant concentrations were set at 10 tons per year for NOx, 0.2 tons per year for PM$_{2.5}$, and 0.01 tons per year for benzene, similar to values for the Norfolk International Terminal. Similarly, Craney Island’s ship at dock emissions were also modeled after NIT ship at dock emissions, and channel segments leading to Craney Island were assigned similar emissions to NIT’s channel segments. As the Port of Virginia foresees 50 percent of all cargo to leave the port by rail, the appropriate conditions were altered. All emissions at the Lambert’s Point railyard were increased by 50 percent and all railway emissions west of Lambert’s Point were increased by 50 percent as well. An assumption was made that all of the cargo coming into the Craney Island Terminal that will travel by rail will be shipped via the Lambert’s Point railyard because it is the closest rail yard to the terminal. From there, it was assumed that the cargo will travel westward, so only the railways west of the Lambert’s Point rail yard were modified.

For road emission values, the I-664 Widening scenario (discussed above) was applied because the interstate widening is projected to be completed before Craney Island’s
construction. This assumes that truck traffic will increase by a proportion of 1.33 on all segments of I-664 and AADT will also increase by 1.33. Similar alterations were applied to multiple segments of S-164 because trucks will most likely travel via S-164 to get from I-664 to Craney Island.

V. RESULTS

Widening of I-664 Scenario

![Figure 1. Percent Difference in NOx Concentration](image1.png)

![Figure 2. Percent Difference in Benzene Concentration](image2.png)
The expansion of I-664 yields different results for the five chemicals. For NOx, particulate matter (PM2.5), and carbon monoxide (CO), there is a general increase in concentration levels in the area surrounding the modified I-664 segments, which can be viewed in Figures 1, 3, and 4. This is expected because all three of these chemicals are known to come from cars and trucks. Therefore, if the amount of vehicles on I-664 increases, one would expect the main emissions found in vehicles to increase, as well. The area directly East of I-664 experienced...
the greatest increase. This is most likely because of the westward wind direction in the winter months. Figure 2 shows the difference in Benzene concentrations is not as straightforward. Benzene emissions mainly come from industries, such as the Asheville-Schoonmaker Mica Co., which produces linens (CDC, 2013). Benzene is not a major chemical found in truck or vehicle emissions, so increased truck traffic on I-664 does not yield any significant change in Benzene concentrations. Therefore, the vast majority of the area is beige in Figure 2, indicating no change or very little increase in benzene concentrations. There are some points on the coast or in the ocean where a significant increase in benzene concentrations is represented with bright red. Our hypothesis is that this is most likely an error in the interpolation process, because there is no reasonable explanation for pockets of benzene to exist in the ocean. Figure 5 shows an equal increase of EC 2.5 concentrations throughout the entire study area. The appearance of Figure 5 may be skewed by potential outliers in the Southwest corner. However the concentration values in this area were not significantly higher than the other values, so the cause of this appearance is uncertain.

Craney Island Expansion Scenario

![Figure 6. Percent Difference in NOx](image)

![Figure 7. Percent Difference in Benzene](image)
Based on the percent difference between the original basemap of benzene concentrations and values generated based on Craney Island scenarios in Figure 7, a plume indicated a maximum 3 percent increase of benzene concentrations extending inland towards Virginia Beach county. In Figure 9, carbon monoxide plumes extend in the same manner as benzene and indicate an 80% increase. Figures 6 and 8 show that NOx and PM 2.5 release flow approximately seven miles southeast of Craney.
Island and indicate a 5000% percent increase for NOx and 4000% increase in PM 2.5 on average. The high percentage values can be explained by the fact that no emissions are currently coming from the Craney Island terminal area, as there is currently no terminal there. In Figure 10, EC concentrations exhibit an unusual behavior based on C-PORT results. Highly concentrated areas of EC 2.5 can be seen continuing approximately seven miles southeast. This is similar to the patterns of NOx and PM 2.5, but EC 2.5 is also heavily concentrated in a region directly south of Hampton county, over inland regions of Portsmouth and north of Portsmouth county. These behaviors are peculiar due to the fact that there is a sharp contrast between on land and directly off shore. Generally, for the Craney Island scenario results that were run assuming stable morning conditions in the winter, trends show an increase in all chemicals in an area that reaches an estimated distance of seven miles. Most of the area in Figures 6-10, or all the beige/yellow areas, indicate no change in concentration levels. This is not surprising because the only attributes modified in C-PORT were directly related to the transportation of goods to and from Craney Island, so areas far away from the terminal do not experience chemical effects from Craney Island, according to this model.

VI. STRESSOR-RELATED EMISSIONS AND HEALTH EFFECTS

For all health effects, this report will present sources, chemicals, and health effects, but it cannot definitively state that these sources are the cause of these health effects. Top emissions will be discussed, but it has not been determined the extent of contribution to this source on health effects. Therefore, this report will focus on documented health effects of relevant chemicals.

Newport News Shipbuilding

Shipbuilding as an industry uses a number of chemicals of concern related to air quality, and a complete list can be accessed at the US Environmental Protection Agency under the Profile of the Shipbuilding and Repair Industry (EPA, 1997). For this project, the Toxic Release Inventory (TRI) chemical releases for Newport News Shipbuilding were investigated. It is
important to note that the extent of contributions to health effects were not researched or described and therefore, it is not known what the specific contributions of Newport News Shipbuilding were to the health effects described in Table 1.

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Chemical Concentration (NIOSH REL)</th>
<th>Symptoms</th>
<th>Respiratory Irritation</th>
<th>Asthma</th>
<th>Cardiovascular Effects</th>
<th>Reproductive Effects</th>
<th>Central Nervous Damage</th>
<th>Eye Irritation</th>
<th>Skin Irritation</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-Butyl alcohol</td>
<td>50 ppm</td>
<td>Impaired hearing and reduced vision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xylene</td>
<td>100 ppm</td>
<td>Eye damage, nausea, and poor coordination</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>1 mg cubic meter</td>
<td>Dental effects and pulmonary edema</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1,2,4-trimethylbenzene</td>
<td>25 ppm</td>
<td>Can lead to anemia, nausea, and headache</td>
<td></td>
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</tr>
<tr>
<td>Ethylene</td>
<td>100 ppm</td>
<td>Headache, irritation of mucous membranes</td>
<td></td>
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<tr>
<td>Copper</td>
<td>1 mg cubic meter</td>
<td>Can cause anemia and damage lungs, liver, and kidneys</td>
<td></td>
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</tr>
<tr>
<td>Manganese</td>
<td>1 mg cubic meter</td>
<td>Causes a cough and fever, leads to nausea and mouth</td>
<td></td>
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</tr>
<tr>
<td>Nickel</td>
<td>0.015 mg cubic meter</td>
<td>Can cause sensitizing dermatitis, allergic asthma, and head injury</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>0.5 mg cubic meter</td>
<td>Associated with lung cancer, initial the eyes and skin</td>
<td></td>
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</tr>
<tr>
<td>Trichloroethylene</td>
<td>*Potential carcinogen, NIOSH level under evaluation</td>
<td>Causes visual disturbances, headaches, potential carcinogen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc (zinc chloride)</td>
<td>1 mg cubic meter</td>
<td>Mental confusion, nausea, and dizziness, which reduces pulmonary function, can also result in vomiting and back pain</td>
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Table 1. Health effects associated with TRI releases in Newport News, VA, including n-butyl alcohol, xylene, sulfuric acid, 1,2,4-trimethylbenzene, ethylbenzene, copper, manganese, nickel, chromium, trichloroethylene, and zinc. This chart includes information from the Centers for Disease Control and Prevention with NIOSH REL which provides an acceptable level for work-related exposures.

In analyzing the community burden, there are several releases from TRI that could prove relevant to the community. According to the TRI, the top emissions from the Newport News Shipbuilding shipyard include n-butyl alcohol, xylene, sulfuric acid, 1,2,4-trimethylbenzene, ethylbenzene, copper, manganese, nickel, chromium, trichloroethylene, and zinc. The health effects are described below as an expansion of the material presented in Table 1.
N-butyl alcohol is associated with irritation of the eyes, nose, and throat, specifically poor vision, tear production, and intolerance to light. It has been associated with dermatitis as well as injury to the auditory nerve, affecting hearing and the central nervous system (CDC, 2011).

Xylene has similar symptoms, causing irritation of the skin, nose, and throat, particularly affecting the cornea. It can also cause central nervous system damage, which results in poor coordination as well as both excitement and drowsiness. It is also correlated with dermatitis, similarly to N-butyl alcohol. In addition, it has been linked to nausea, vomiting, abdominal pain, and anorexia (CDC, 2011).

Sulfuric acid also irritates the eyes, skin, nose, and throat. It can also cause dermatitis. However, unlike n-butyl alcohol and xylene, it has been linked to pulmonary edema, bronchitis, emphysema, and dental erosion (CDC, 2011).

1,2,4-trimethylbenzene also irritates the eyes, skin, nose and throat, and it is linked to exhaustion, dizziness, and nausea. Bronchitis and respiratory irritation can occur as well as hypochromic anemia (CDC, 2011).

Ethyl benzene also irritates the eyes, skin, and mucous membranes. Additionally, it can cause headaches and dermatitis, with severe symptoms ranging to narcosis and comas (CDC, 2011).

Copper is important because it too can cause irritation in the eyes, nose, and respiratory tract, particularly by perforating the nasal septum. It is also related to dermatitis and can cause damage to the liver, lungs, and kidneys, particularly by Wilson’s disease which is found in animals. Lastly, it can cause anemia (CDC, 2011).

Manganese has been attributed to various symptoms, including fevers accompanying a cough and difficulty breathing. Exposure to manganese can also result in insomnia. Manganese can also cause kidney damage, low-back pain, and feelings of discomfort, weakness, and exhaustion (CDC, 2011).
Nickel is known to cause symptoms including sensitizing dermatitis, allergic asthma, and pneumonitis. Additionally, it is a potential carcinogen in lung and nasal cells (CDC, 2011).

Chromium, like most other ship-building related chemicals, is known to irritate the eyes and skin. It is also associated with histologic lung fibrosis (CDC, 2011).

Trichloroethylene irritates the skin and eyes, causing visual distortions and headaches as well as dermatitis. It also causes drowsiness, dizziness, vomiting, and nausea. The kidney and liver cells are susceptible to cancer development in this potential occupational carcinogen. It can also cause cardiac arrhythmia, tremors, and paresthesia (CDC, 2011).

Zinc, in the form of zinc oxide, is associated with metal fume fever, consisting of chills, muscle pain, nausea, fever, and a cough stemming from a dry throat. It can be identified by a metallic taste and causes reduced breathing function and chest tightness stemming from lowered pulmonary function. Moreover, it can also result in low back pain, vomiting, and feelings of discomfort (CDC, 2011).

In addition to these TRI releases, there are several processes, including welding, painting, and abrasive blasting, that can have a large impact on shipbuilding workers and employees of nearby businesses. Welding, which involves heating and manipulating metal, can produce several hazardous vapors from the heating of steel and aluminum alloys, including oxides of nitrogen, nitrogen dioxide, cadmium, iron oxides, zinc oxides, chromium, cadmium, and manganese. Some of the most serious concerns derive from exposure to metals. For instance, chromium is a probable carcinogen, cadmium is a known carcinogen, and other metals are associated with ‘metal fever,’ which generally consists of a short period of fever, nausea, and coughing, according to the Occupational Safety and Health Administration (OSHA). As there are a number of potential carcinogens released in shipbuilding processes and Newport News shipbuilding, specifically, the cancer rates in Hampton county were investigated.
Figure 11 reveals that Hampton county has one of the highest rates of cancer in Virginia. The type of cancers could be further investigated to identify whether these consist of pollution-related cancers. It remains important to note that the contribution of Newport News shipbuilding or its releases were not investigated and therefore, conclusions cannot be drawn with respect to the impact of shipbuilding on health impacts in Newport News.

For instance, cadmium can be released into air, soil, and water, existing as an oxide, chloride, and sulfate from high temperature processes. When released, cadmium can travel great distances. In addition to its release through shipbuilding processes, cadmium can be found in tobacco and leafy vegetables. Cadmium can impact the lungs at high levels. If one is exposed to cadmium over time, he or she can experience kidney damage. Also, workers who are exposed to cadmium for long periods of time have higher chances of lung cancer (ATSDR, 2015a).

Chromium, particularly hexavalent chromium, which is produced by industrial processes such as shipbuilding, is particularly corrosive and causes irritation and corrosion. By interacting with hydrogen peroxide, ascorbic acid, or glutathione reductase, it forms chromium V, chromium IV, thyl radicals, hydroxyl radical, and chromium III which can attack proteins, DNA, and cell membrane lipids. These can have harmful effects on cell functioning. Breathing in chromium dust causes pulmonary irritation, including asthma and bronchitis. Exposure also increases the risk of sinus, nasal, and lung cancer, as it is a human carcinogen. It can take as long as 20
years for cancer to form. Furthermore, if one is exposed dermally to chromium, it is likely that one can develop irritant and allergic contact dermatitis which leads to skin conditions such as dryness and erythema (redness). As such, chromium exposure causes great skin sensitivity (ATSDR, 2008).

In addition to welding, there are a number of air contaminants associated with abrasive blasts, which occur in the smoothing process within shipyards. The chemicals outlined in this research were found in Turkey, but similar compounds and health effects would likely be found at the Newport News Shipbuilding yard. These include several metals, such as aluminum and copper, which cause respiratory irritation, along with contaminants that have been linked to lung cancer, including arsenic, cadmium, chromium, cobalt, nickel, etc. Other chemicals that are released in the abrasive blasting process include cobalt, lead, crystalline silica, tin, titanium, zinc, and copper (Celebi et al., n.d.).

When ships are painted, volatile organic compounds are emitted as well as hazardous air pollutants. Additionally, the cleaning of equipment produces many hazardous wastes in the form of solvents, thinners, and acids. Other organic solvents are used to dissolve paints, in addition to oil, wax, rubber, and varnish; these shipbuilding materials have chemicals potentially tied to neurological concerns. In addition to the Asheville-Schoonmaker Mica Company releasing toluene, toluene could also be released by Newport News Shipbuilding, as it is used as a cleaning and degreasing solvent (Celebi et al., n.d.).
Toluene Reaches from the Asheville-Schoonmaker Mica Co.

Table 2. Health effects associated with Toluene, a by-product of mica production

**Associated Health effects**

Toluene is a clear liquid, which can be converted to benzene and xylene, according to the Agency for Toxic Substances and Disease Registry (ATSDR). Toluene has a distinctive smell at eight parts per million, but it is important to note that 75 percent of toluene is removed within 12 hours of entering the body. It leaves the body by exhalation or urination, largely as less harmful chemicals such as hippuric acid (ATSDR, 2015).

In considering Table 2, it is important to note that the specific contribution of toluene to health effects in Newport News was not investigated. However, according to the Agency for Toxic Substances and Disease Registry, in general, if one is exposed to a large amount of toluene, it can cause a number of neurological effects, including headaches, sleepiness, and cognitive function. These symptoms generally occur during exposure and go away once the exposure decreases. Furthermore, it is important to note that researchers are unsure of the effects of low levels on the brain and body over time (ATSDR, 2015b).
At high levels, toluene can adversely impact kidneys and can interact with substances such as alcohol, aspirin, and acetaminophen. Furthermore, it has been suggested that toluene can cause reproductive effects, but ATSDR suggests that the increased risk of spontaneous abortions is influenced by other factors as well, including cigarette smoking and alcohol use. Mothers with higher toluene exposures during pregnancy are more likely to have children with birth defects, including delayed cognitive and physical development. This is likely due to the fact that human fetuses and newborn children have limited detoxification abilities, and their capacity for detoxification does not form until the age of three (ATSDR, 2015b). Specifically, in Newport News, VA, there were 30 infant deaths in 2009, which accounted for 4.0 percent all infant deaths in the Commonwealth of Virginia. Furthermore, in Newport News, the infant death rate was 9.4 per 1,000 live births in 2009 compared to 7.0 for the Commonwealth of Virginia (Virginia Department of Health, 2015). Although these statistics are not toluene-specific, it is possible that toluene exposures could contribute to this numbers and future research could investigate this further.
Table 3. Chemicals (in C-PORT) associated with highway emissions, including particulate matter (PM 2.5), acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, carbon monoxide, nitrogen oxides (NOx), sulfur oxides (SOx), and volatile organic compounds (VOC). The associated health effects are listed in this table.

Table 3 describes the wide-ranging health effects resulting from air pollution associated with motor vehicles. Given the limited time available, this study focused on three serious health effects of interest to the community: childhood asthma, cardiovascular disease, and diabetes and research related to these chemicals. As such, research is provided on these health outcomes below.

Associated Health Effects

a. Childhood Asthma

Asthma is a respiratory disease characterized by obstructed, mucus lined, and chronically inflamed air passages which leads to shortness of breath and scarring in the airways. The costs
associated with asthma were $50.1 billion annually for direct healthcare costs and $5.9 billion for indirect costs such as reduction in worker production (American, 2015). Childhood asthma is particularly important because it is estimated that 11 percent of the U.S. population may be afflicted with asthma, and most cases develop in childhood (Chunn and Wagner, 2008).

Asthma can be caused by genetic features and environmental exposures. However, the prevalence of asthma continues to rise, and this points to the increased role of environmental influences (Chunn and Wagner, 2008). Children are especially vulnerable because exposure to pollutants while their airways are developing can result in irritation and hypersensitivity (Kenyon and Liu, 2011).

This is alarming as asthma is the third leading cause of hospitalization in children less than 18 years old in the U.S., with the prevalence of asthma nearly doubling from 1980 to 2003 (Chunn and Wagner, 2008). As such, Pandya et al. suggests that research and public health action should be particularly targeted at factors related to asthma in children (Pandya et al., 2002).

According to the CDC, low-income and minority populations, as well as inner-city children, have increased emergency department visits, hospitalizations, and deaths related to asthma when compared to the general population—a disparity that should be further investigated and addressed (CDC, 2013). As one can see from Figure 12, it seems that overall childhood asthma rates are low in Newport News and surrounding areas. This could be due to a variety of
factors, such as low population of young personnel and minimal utilization of hospital resources for asthma attacks.

<table>
<thead>
<tr>
<th>Location</th>
<th>Deaths</th>
<th>Total Population</th>
<th>Rate per 100,000</th>
<th>Year(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newport News</td>
<td>370</td>
<td>541,829</td>
<td>68.3</td>
<td>2010-2012</td>
</tr>
<tr>
<td>Virginia</td>
<td>5920</td>
<td>8186628</td>
<td>72.3</td>
<td>2012</td>
</tr>
</tbody>
</table>

Table 4. Statistics related to asthma in Newport News, VA (CDC Wonder)

b. Cardiovascular Disease

The prevalence of cardiovascular disease continues to rise, affecting more and more adults each year. For instance, according to the CDC, 610,000 people die of heart disease each year, accounting for one in every four deaths. Heart disease is the leading cause of death among men and women, and among men, heart disease deaths accounts for more than 50 percent of all deaths. Furthermore, 735,000 Americans have a heart attack each year, with 525,000 people having a first attack and 210,000 having a repeat attack. Heart disease is the leading cause of death among African American, Hispanic, and White populations, with 24.5 percent, 20.8 percent, and 25.1 percent of deaths, respectively. Furthermore, it appears that the American South has the highest rates of deaths due to cardiovascular disease (CDC, 2015).

With these alarming statistics, there have been a number of studies related to potential correlations between cardiovascular disease and environmental exposures, particularly particulate matter. One study shows that an increase in pollution such as smaller particulate matter (PM 2.5) results in an increase in cardiovascular death. For instance, Landen et al. found
that the relative risk for cardiovascular death increases by 1.28 for every ten micrograms per cubic meter PM 2.5 elevation. Another study identified that a ten microgram per cubic meter elevation of PM2.5 daily results in an 8.6 mm Hg increase in systolic blood pressure. Additionally, many studies have cited the long-term increased risk of cardiovascular death with chronically elevated PM 2.5 exposure (Franchini and Mannucci, 2012).

In addition to particulate matter 2.5 (PM 2.5), Biggeri et al. identifies a 0.4 percent increase in cardiovascular deaths for each 10 micrograms per cubic meter NO2 elevation, a 0.9 percent increase in cardiovascular deaths for each 10 microgram per cubic meter CO elevation, a 1.1 percent increase in cardiovascular deaths for each 10 microgram per cubic meter SO2 elevation. Furthermore, a study performed by Ibald-Mulli identified that systolic blood pressure elevates by 1.79 mm Hg (millimeters of mercury) per 90 microgram per cubic meter increase in total air particles. Furthermore, it has been shown that living near a major roadway is associated with cardiopulmonary mortality, according to a study performed by Hoek. Overall, air pollution exposure can affect the prevalence of cardiovascular disease (Franchini and Mannucci, 2012).

<table>
<thead>
<tr>
<th>Location</th>
<th>Rate (per 100,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newport News</td>
<td>181.4</td>
</tr>
<tr>
<td>Virginia</td>
<td>162.9</td>
</tr>
<tr>
<td>U.S.</td>
<td>174.7</td>
</tr>
</tbody>
</table>

**Table 5.** Statistics related to cardiovascular disease in Newport News compared to Virginia and U.S. (CDC Interactive Atlas of Heart Disease)

In addition to pollution, there are several important contributing factors, including lifestyle choices and behavioral attributes. For instance, having high blood pressure, high LDL cholesterol, diabetes, being overweight or obese, eating poorly, lacking physical activity, drinking in excess, and smoking place individuals at a greater risk of heart disease (CDC, 2015). These factors must be considered when analyzing the prevalence of cardiovascular disease in Newport News and the Hampton region, as provided in Table 5.
c. Diabetes

Similar to cardiovascular disease, the prevalence of diabetes continues to rise, and there are a number of complex factors contributing to diabetes. This increase in prevalence is largely attributed to an increase in type II diabetes, where insufficient amounts of insulin are produced or the cells are resistant to insulin. Diabetes was the seventh leading cause of death in the U.S. in 2001, and it is characterized by chronic high blood glucose levels because insulin, a pancreatic hormone, does not appropriately control blood glucose levels (AHRQ, 2001), (Harvard, 2015).

Diabetes seems to disproportionately impact certain populations, particularly minority populations, including non-Hispanic blacks, Mexican Americans, and American Indians. Diabetes is responsible for many cases of kidney failure in the U.S., causing 34 percent of treatments for end-stage renal disease in 1990. Diabetes-related kidney failures and retinopathy, a complication that causes blindness, disproportionately impact African Americans. These contributions result in a higher diabetes-related mortality rate for African Americans, Hispanic Americans, and American Indians than for white people (AHRQ, 2001).

<table>
<thead>
<tr>
<th>Year</th>
<th>% of Population</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>13.5%</td>
<td>17783</td>
</tr>
<tr>
<td>2011</td>
<td>12.6%</td>
<td>16383</td>
</tr>
<tr>
<td>2010</td>
<td>11.2%</td>
<td>14659</td>
</tr>
<tr>
<td>Statewide (2012): 9.8%</td>
<td>(Source: CDC Diabetes Data and Statistics)</td>
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</table>

Table 6. Statistics related to diabetes in Newport News compared to Virginia (CDC)
It is important to note that this disease is tightly linked with the ‘epidemic of obesity,’ whereby behavioral factors play a large role in vulnerabilities of diabetes, particularly type II diabetes (Lockwood, 2002). However, in addition to behaviors that contribute to diabetes, including a poor diet and a lack of exercise, it is possible that air pollution also contributes to the formation of diabetes (Rajagopalan and Brook, 2012). As Eze et al. states, experimental evidence of air pollution affecting the etiology of diabetes is suggestive, but epidemiological evidence is limited and does not paint a clear picture. Some factors that contribute to this uncertainty are varying quantification of exposure, diabetes definitions as well as influences on populations. An important confounder, or item that distorts the relationship between air pollution and type II diabetes, is noise, which generally accompanies high levels of pollution and has shown to affect cardiovascular disease as well as sleep quality/quantity, which are correlated with type II diabetes. However, it is important to note that cardiovascular disease has many similar risk factors as type II diabetes, and therefore, it is possible that air pollution could be involved similarly. There are several proposed mechanisms including “oxidative stress and low grade inflammation, endothelial dysfunction, visceral adipose tissue inflammation, endoplasmic reticulum stress, and mitochondrial dysfunction.” Furthermore, animal studies point to the concern that fine particles can contribute to insulin resistance when coupled with a high fat diet. In a data performed in a Swiss cohort, Eze et al. states that long-term exposure to large particulate matter (PM10) and nitrogen dioxide were found to positively associate with diabetes mellitus, largely type II diabetes cases, and were found to be independent of traffic-related noise.
exposure (Eze et al., 2014). It seems that this field of study could be of great interest and future research could be beneficial. Diabetes in Newport News, Virginia and the Hampton region should be particularly investigated as these areas have relatively higher rates of diabetes, as seen in Table 6 and Figure 13.

**VII. PORT-RELATED SOLUTIONS**

Given these stressors and health effects, as well as changes that could affect Newport News, Virginia, it seems important to document proposed solutions, utilizing government and academic resources to inform and empower the community.

**Community Solutions (How can we come together to improve conditions?)**

There are a number of solutions that the surrounding communities of the Port of Virginia could implement to improve conditions.

With regard to potential improvements, it could be helpful for concerned businesses and residents to band together to form a port advisory committee with personnel from local businesses, the Greater Southeast Development Corporation, the Virginia Health Department, and the Virginia Department of Environmental Quality, similar to the port communities of New York and Los Angeles (LA) and Long Beach (LB). This committee could involve creating a community bulletin with information relevant to Newport News locals and those elsewhere about port operations and opportunities. Additionally, this committee could create a community council with community stakeholders, such as residents, to provide items such as public notices. These public notices can notify residents of public meetings to discuss port-related activities and issues (Tracking Harm, 2012).

By recognizing the importance of ports in the Hampton area and Newport News, it becomes possible to have discussions about how to improve the Newport News area for all. For instance, the community can communicate with the port and request restricted hours, barriers between port operations and the surrounding community, and the maintenance of areas near the port in order to improve living conditions and boost the esteem of the area. This has proven
to be successful in other ports via the “Green Port Policy,” a coordinated approach to reduce the negative impact of port operations with five main principles: protecting the community from harmful port impacts, creating the port as a steward of the environment, utilizing sustainable practices, employing the most up-to-date technology, and engaging with the community (Port, 2015a; Port, 2015b).

Once engaged with the port, there are a number of different goals that could be set to improve air quality. For example, it would be helpful to create a facility truck operating limit to reduce traffic and traffic-related incidents (Tracking Harm, 2012).

Additionally, it could prove beneficial to the port and the port community’s rejuvenation if efforts were made to enhance recreational development. Other ports such as Los Angeles (LA) have recreational beaches, museums, bike paths, and a trolley line, as well as efforts to revitalize tourism and local waterfront business. LA also has cruise terminals and craft marinas to draw in business (Port, 2015a; Port, 2015b).

Another idea stemming from the success of the port of LA is the development of an air quality monitoring program. This program could provide the constant monitoring of hot spot areas where pollution levels are high. This would require partnering with the EPA and the Virginia Department of Environmental Quality. LA created a Clean Air Action Plan to assist in these efforts, and it closely communicates with the advisory committee that is comprised of community members—ultimately ensuring port-community cooperation (Port, 2015a; Port, 2015b).

Federal and State Government Solutions (What actions can occur on a larger scale?)

The Port of LA’s Clean Air Action Plan is a comprehensive strategy to cut air pollution by 45 percent and reduce health risks within five years. One of its components is the Technology Advancement Program; this program identifies technologies in port industries that can reduce emissions. This could include retrofitting equipment less than 10 years old and retiring equipment 10 or more years old, ultimately promoting the use of the cleanest available
technology. For example, diesel particulate filters can be updated with clean nitrogen oxide catalysts. If clean nitrogen oxide catalysts are not an option, diesel oxidation catalysts should be used as the next best solution. This could also occur by switching diesel fuel locomotives to electric equipment that creates zero emissions or diesel fuels with a lower-sulfur content, which could reflect the progress made at the LA and San Pedro Bay that uses zero emission technology and takes action to reduce dependence on foreign oil (Port, 2015a; Port, 2015b).

Furthermore, replacing older trucks with modern-lower emitting trucks would greatly enhance initiatives to reduce emissions. However, it is likely that an incentive program is needed to further this goal. Loans could be given to truck drivers who update to more efficient trucks, as used in Houston, or trucks that are older than a certain year could be banned, as is performed in New York. Lastly, the use of heavy-duty diesel engines could be reduced, as is used in California’s Carl Moyer and Gateway Cities programs. This would advance the already-implemented solution of the Green Operator Program, which retrofits and replaces trucks manufactured prior to 2007 in over 400 trucks to reduce various air pollutants, including nitrogen oxides, volatile organic compounds, and particulate matter (Harboring Pollution, 2004).

The port of LA and port of Long Beach provide similar incentives to ships that reduce emissions and travel at lower speeds near ports to reduce pollution. They honor these participants with CAAP Self-Sufficiency awards to acknowledge commitments made to reducing air pollution. A similar program could occur in the Commonwealth of Virginia. For instance, emissions from ships could be reduced if ships are required to plug into power while docked, use low-sulfur fuel, and create incentives for retrofitting or replacing older ships. With regards to plugging in for power, there is an interesting program called Alternative Maritime Power, which reduces emissions by plugging into electrical power sources while docked. This program could become active in the Newport News and surrounding areas. Another important party that could be involved in such an initiative is the EPA who has the authority to implement stricter emission standards and fee ships with high pollution levels (Harboring Pollution, 2004).
In addition to direct port improvements, it is important to consider the impact of port-related freight movement. As such, Virginia Department of Environmental Quality could implement recommendations presented by the State Air Pollution Control Board to require a minimum distance between rail yards and schools, potentially using C-PORT to identify less polluted areas (Hricko, 2014). An improvement of port facilities could promote a more attractive harbor district and could have long-term effects on state and national goods movement and subsequent policies.

These potential solutions would involve working with a number of different state and federal partners, including the VPA, Virginia Clean Cities (VCC), the Mid-Atlantic Regional Air Management Association, the EPA, the U.S. Department of Energy, and the Virginia Department of Environmental Quality. Some of these organizations could help provide funding for these solutions.

Additionally, it is important to acknowledge the importance of environmental reviews of new and expanded facilities, such as that of Craney Island, to investigate the demographics and locations of those affected (Hricko, 2014). The Environmental Review Procedure Manual and HIA Toolkit can be accessed at the Virginia Department of Environmental Quality website (DEQ, n.d.)

Finally, continued partnerships with academic institutions seems to be promising. This research could assist with exposure assessment as well as the evaluation of zero emission technologies for locomotives, trucks, and rail equipment.

**IX. STRESSOR-RELATED SOLUTIONS**

**Newport News Shipbuilding Company**

a. **Individual and Interpersonal Solutions (What can my family do for themselves?)**

With regard to attempting to prevent negative health effects of the various chemicals emitted from shipbuilding processes, it is important to reduce exposure to tobacco products. Cadmium from tobacco can significantly increase blood cadmium levels, with the average adult
level at 0.376 micrograms per liter. Moreover, the mean cadmium blood level for heavy smokers is 1.58 micrograms per liter. Smoking also impacts other metallic levels such as chromium. Furthermore, as standards should be taken to reduce cadmium exposure at work, it is important to consider that parents working in cadmium-related industries, such as shipbuilding, should bathe and change clothes prior to entering the home to reduce the contamination of home items and the exposure of household members to cadmium. Regarding tests for cadmium exposure, blood tests can be taken to evaluate key organs, including the liver and kidneys (ATSDR, 2015a). If one is concerned about cadmium or other exposures, there is a federal Agency for Toxic Substances and Disease Registry (ATSDR) information line that can be accessed at 888-422-8737 and the Virginia Department of Health and the Peninsula Health district can be contacted (Virginia.gov, 2015). It is important to note that it is difficult to attribute specific health effects to particular chemicals coming from a particular industry. In the fall of 2015, resources will be made available to employees of the Huntington-Ingalls Shipbuilding industry as the shipbuilder is building an on-site health center.

b. Community Solutions (How can we come together to improve conditions?)

Continuing education initiatives could help community members be aware of certain health effects. The community could also form a committee that involves military personnel because Newport News Shipbuilding builds ships for the military. Partnering with military personnel could give the community more sway with the shipbuilding company as it tries to reduce community exposure to chemicals and metals, such as cadmium. This partnership could help the community engage with the company and discuss potential health impacts—particularly health impacts on shipbuilding workers.

c. Federal and State Government Solutions (What actions can occur on a larger scale?)

A shipbuilding-related initiative that would fall in line with the Green Port Policy would be retiring equipment that is ten or more years old and replacing it with the cleanest available technology and fuel. This initiative would occur at a state level. As diesel-fueled cranes have
already been replaced with electric cranes and retrofitting trucks to meet EPA standards, this
could occur at Newport News shipbuilding via policy implementation.

**Asheville-Schoonmaker Mica Co. and Related Toluene Releases**

**a. Individual and Interpersonal Solutions (What can my family do for themselves?)**

On an individual level, toluene can have adverse interactions with alcohol and
medications such as acetaminophen. Toluene exposure in addition to alcohol consumption can
damage the liver, and toluene interactions with medications such as acetaminophen and aspirin
can impact one’s hearing. In addition, reproductive effects are thought to stem from a
combination of toluene and other chemical exposures, as well as cigarette smoking and alcohol
consumption. Therefore, it is important to reduce these contributing behaviors to reduce the risk
of reproductive effects (ATSDR, 2015). As such, resources for quitting smoking can be found at
a number of programs, including the CDC. Resources for reducing alcohol consumption and
quitting smoking are also available (NHS, 2014).

Children are more susceptible to toluene exposure that adults. If this of concern in your
family, one should contact the State Department for Investigation, specifically the Virginia
Department of Health (Virginia.gov, 2015). Families can also ensure that their homes have
proper ventilation systems in order to prevent or address this concern. Furthermore, if families
live near areas with high toluene releases, levels that are released must be monitored by the
National Release Center if they exceed 1,000 pounds (ATSDR, 2015).

For concerns about toluene exposure, one can also contact ATSDR at 1-800-CDC-INFO
or 888-232-6348 for additional information on exposure and treating associated illnesses
(ATSDR, 2015).

**b. Community Solutions (How can we come together to improve conditions?)**

Community solution options to mitigate the effects of toluene are limited, but one
community solution is viable. The community can take steps to decrease atmospheric toluene
by planting certain plants in public areas. For example, new research states that the Boston
Fern, the Lady Palm, and certain ivy plants, among other toluene-reducing plants, can reduce atmospheric toluene. This could improve the air quality of the Newport News community by reducing the proportion of toluene in the atmosphere. These plants can also be potted and placed in public buildings, including schools and civic centers (Felber 2015).

c. Federal and State Government Solutions (What actions can occur on a larger scale?)

As the toluene releases are documented from mica companies, it could be possible to investigate the use of alternative mica processes or solvents on a larger scale. Future research on potential alternative solvents to use in mica production is necessary because of the limited knowledge relating to mitigating toluene emissions. It is important to note that although toluene can come from a number of different sources, toluene from mica production significantly adds to the air pollution burden and could be further investigated by state or federal policy accordingly, expanding on the regulation of toluene by the Toxic Substances Control Act, the Emergency Planning and Community Right-to-Know Act, Clean Air Act, Comprehensive Environmental Response, Compensation, and Liability Act, and Resource Conservation and Recovery Act as well as measured by Toxics Release Inventory Data (EPA, 1994).

Interstate 664 and Related Releases

a. Individual and Interpersonal Solutions (What can my family do for themselves?)

i. Childhood Asthma

According to the National Heart, Lung, and Blood Institute, asthma cannot be prevented on an individual level. However, the disease can be controlled, and its symptoms can be managed (NIH, 2014). These solutions will focus on efforts that can be made at the individual, family, and school level. As there are connections between asthma and air chemicals, it is likely that a reduction in these chemicals could also alleviate symptoms of asthma.

There are certain environmental items to be wary of as they may “trigger asthma symptoms.” They include particles such as dust, mites, tobacco smoke, and environmental pollutants (CDC, 2013). If possible, efforts should be made to reduce the presence of these in
the home by reducing exposure to tobacco smoke, dust, mites, etc. Some worry that exercise could lead to exacerbation of symptoms, but the National Institutes of Health states that it is necessary for a healthy lifestyle and to prevent other chronic diseases (NIH, 2014).

Additionally, one should create an “Asthma Action Plan,” provided for free at the NIH website to learn what to do when one is feeling well, worse, and in need of medical care. This guide provides key symptoms and medical recommendations and should be filled out with a doctor (NIH, 2014).

The “Asthma Action Plan” also provides a guide with steps to prevent making asthma worse. First, there are many allergens that can aggravate asthma. For example, for animal dander, the NIH recommends keeping furry or feathery creatures outdoors and minimizing the contact they have with fabric-furniture and sleeping locations. For dust mites, the NIH recommends encasing mattresses and pillows in a dust-proof cover. If unavailable, the pillow should be washed in hot water, greater than 130 Fahrenheit, to kill the mites, which are tiny bugs. Similarly, the sheets, blankets, and fabric-based toys should be washed in hot water each week with a dehumidifier to remove moisture from the air. Regarding cockroaches, the dried feces can trigger asthma, and food should be kept covered. If roaches are identified, traps and powders can be used to address the problem. Indoor mold can occur through leaky faucets and should be cleaned with bleach to prevent asthma attacks. Outdoor mold and pollen can be minimized by keeping windows closed, spending little time outdoors between late morning and afternoon (as spore levels peak in this time), and adjusting medication (NIH, 2014).

Secondly, there are a number of irritants that can exacerbate asthma. For instance, tobacco smoke should not be allowed in the home, and a physician should be contacted to assist in quitting. Other sources of smoke, such as a wood-burning stove, kerosene heater, fireplace, and sprays, such as perfume, talcum powder, hair spray, and paint, can aggravate asthma and should be minimized. Along these lines, vacuuming can trigger asthma, so a dust mask or double-filtered vacuum bag is recommended while vacuuming. Other items to be aware
of include sulfates in beverages and food. Sulfates are in beer, wine, dried fruit, processed potatoes, and shrimp, and they may cause asthmatic symptoms. Cold air and strong winds can also affect asthmatics, and one should attempt to cover his or her nose and mouth with a scarf when in cold air or strong winds. Although this is a rather long and comprehensive list, it provides potential ways to combat items that can aggravate asthma in the home and environment (NIH, 2014).

Furthermore, it is important to retain a strong relationship with a physician to monitor and adjust medical care for asthma. In the school environment, successful programs include access to medical professionals, targeting children with severe asthma, providing an “asthma-friendly” environment, and providing education to the students and staff on asthma (CDC, 2013).

Specifically regarding treatment and prevention, there are two types of medicine that can treat asthma: long-term control, which prevent symptoms, and quick-relief medications, which help when symptoms are present (NIH, 2014b).

Long-term medications should usually be taken daily to prevent asthma attacks and symptoms. These generally include inhaled corticosteroids which are not the same as illegal steroids discussed in sports, as well as other medications. Quick relief medications relax the muscles in the airways to assist with breathing, and all people with asthma should have this medication on hand. These are often inhaled short-acting beta-agonists and can be provided by an inhaler. This inhaler should be carried at all times but does not replace the use of long-term medication. This is a brief overview of available medications, but one should refer to medical professionals, such as doctors, to identify which medications and treatments are appropriate (NIH, 2014b).

It is also noteworthy that inhalers are important to preventing an asthma attack, but 30 percent of children with inhalers still have an event requiring an oral corticosteroid treatment each year. It seems that neutrophilic inflammation, which inhalers are not as effective at treating, plays an important role in asthma events. This is important to note because, if air
pollution is prominent and an inhaler does not seem to be effective, one should seek medical advice on potential remedies (Martinez 2009). However, it is important to consider that inhaled corticosteroids can affect growth rates in young children and bone strength in older adults (NIH, 2014b).

Regarding programs that could provide assistance for patients with childhood asthma, a number of Virginia and surrounding area programs on childhood asthma could be found here at the DCAsthma website (DCAsthma, n.d.). This website provides links to state and federal initiatives on childhood asthma. Furthermore, Eastern Virginia Medical School is working on a Community Coalition to address pediatric asthma.

**ii. Cardiovascular Disease**

As cardiovascular disease affects both genders and many ethnicities, prevention of cardiovascular death relies on education about key symptoms. For instance, only 27 percent of a 2005 survey were aware of the warning symptoms of a heart attack, including chest pain/discomfort, pain in arms, back, neck, jaw, or upper stomach, shortness of breath, nausea, light headedness, and cold sweats. It is likely that this lack of knowledge is why 47 percent of sudden deaths due to cardiac issues occur outside of a hospital (CDC, 2015). This can be prevented in Newport News and surrounding areas by discussing key influences and signs.

Provided the behavioral and lifestyle influences on the development of cardiovascular disease, one can attempt to address a number of behavioral factors to prevent cardiovascular disease. Although altering one’s behavior can be challenging, these actions can be taken on an individual level and might diminish symptoms associated with air pollution. Among these, one can contact a physician to discuss quitting smoking, lower blood pressure and cholesterol, eat a diet low in salt, total fat, saturated fat, and cholesterol, and eat many fruits and vegetables. One can also exercise for 30 minutes five times a week (CDC, 2015). In this recommendation, it
should be noted that Newport News is considered to be a place of low income and low food access identified by the US Department of Agriculture (USDA, 2015).

In addition to these items, the Mayo Clinic recommends getting quality sleep, ideally seven to nine hours of sleep each night. A lack of sleep can place one at greater risk for obesity, high blood pressure, heart attack, diabetes, and depression. Additionally, as high blood pressure and high cholesterol can lead to heart disease, one should participate in common screenings. Blood pressure should be checked every two years and should ideally be less than 120/80 mm Hg (millimeters of mercury). Cholesterol should be checked every five years after the age of 20 if one has high blood pressure or is obese; family history could also affect the frequency of recommended measurements. Diabetes is also a risk factor for developing heart disease and therefore, so one should also get tested for diabetes (Mayo, 2015).

iii. Diabetes

It is important to get tested for diabetes, as 6 million Americans with diabetes go undiagnosed. Diabetes remains the leading cause of blindness and kidney failure in adults; if undiagnosed, severe nerve damage can occur to the extent that a limb might need to be removed. However, diabetes is largely preventable. According to the Harvard School of Public Health, nine out of ten cases can be prevented by controlling one’s weight, exercising frequently, eating a healthy diet, and not smoking. It has also been shown that drinking moderate levels of alcohol can reduce vulnerability to diabetes (Harvard, 2015).

57 million adults have “pre-diabetes,” which is indicated by high blood sugar levels on a glucose tolerance test or a fasting glucose test. If deemed pre-diabetic, one can prevent diabetes using the above steps to bring blood glucose levels back to normal levels (Harvard, 2015).

As diet does play a large role in the formation and symptoms of diabetes, it is important to maintain a well-balanced diet. A high fat diet contributes to insulin resistance, an aspect of type II diabetes, so it is important to restrict the type and quantities of fat consumed (Eze et al.,
There are four dietary changes that the Harvard School of Public Health recommends to improve one's diet. First, one should choose whole grain items over highly-processed carbohydrates. Secondly, one should not drink sugary drinks such as soda. The substitution of sugary beverages for water, coffee, or unsweetened tea can reduce inflammation, weight gain, and insulin resistance. Thirdly, there are certain fats to avoid, such as those in margarine, packaged baked items, fried food, etc. Replacing these items with 'good fats' from nuts and seeds can reduce one’s vulnerability to diabetes. Fourthly, one should eat more nuts, whole grains, poultry, and fish—instead of red and processed meat (beef, pork, lamb, bacon, hot dogs, deli meats) (Harvard, 2015).

One can take the ‘Am I at risk quiz?’ provided by the CDC. This quiz assesses one’s risk and describes vulnerabilities among men and African Americans. Community members could take this quiz and have a meeting to discuss the results. Additionally, it seems that a beta-blocker medication protect against exposure to larger particulate matter (PM 10) (Eze et al., 2014). Additionally, it is important to stop smoking to reduce the risk of developing diabetes (Harvard, 2015). Among African Americans with diabetes, the use of social support is important to manage one’s disease, particularly diet maintenance, medication compliance, and monitoring one’s blood sugar (AHRQ, 2001).

b. Community Solutions (How can we come together to improve conditions?)

Within one’s community, education could play an important role. As such, there is an opportunity to form an education program to create a school environment that does not aggravate asthma. Taking asthma as an example, principals and gym teachers can provide indoor fitness on days with higher air pollution levels so that children with asthma do not exhibit as many asthma symptoms. To facilitate this, a school flag program could be created to indicate which days have higher pollution. This would involve purchasing a set of five flags, and raising a particular flag depending on the Online Air Quality Index score (AirNow, n.d.). A list of possible
schools and contact information can be found at the Newport News Public Schools website (Newport, 2015).

Additional education initiatives could include writing and publishing newspaper articles for the community and school programs for children that describe the effects of air pollution and provide information on how to prevent and manage diseases such as cardiovascular disease, asthma, and diabetes. This could be achieved by reaching out to local newspapers, school boards, and the Parent-Teacher Organizations for the Newport News area.

During the summer, faith-based organizations can provide summer enrichment programs for children. These enrichment programs can incorporate environmental health information into their curriculum. Newport News can use the Freedom Schools Program as a model when developing faith-based summer enrichment programs.

Community behaviors can also improve these conditions. For instance, increased awareness of public transportation options could decrease traffic congestion on I-664. The community could advertise the route schedule on posters, radio stations, schools, and businesses.

In addition to altering behavior, it is possible for the community to collaborate with the I-95 Corridor Coalition to improve road conditions and congestion. For instance, a Virginia representative has identified a bottleneck in Chesapeake and has subsequently requested a shift from truck to rail as well as the use of double stack trains to increase efficiency. This is one example of how collaborations could result in a direct change in terms of highway use.

**c. Federal and State Government Solutions (What actions can occur on a larger scale?)**

In addition to the community-oriented solutions, it seems that the adoption of a FIRST system (Freight Information Real-time System for Transport) similar to the one the ports of New York and New Jersey has implemented could greatly benefit the Port of Virginia. This system has a website providing information on ship, rail, and truck arrivals/departures.

**X. CONCLUSION**
The Port of Virginia, Newport News Shipbuilding, the Asheville-Schoonmaker Mica Co., and I-664 are all important to the Newport News economy. As mentioned previously, Newport News Shipbuilding employs more than 23,400 people, many of whom are Newport News residents. The Asheville-Schoonmaker Mica Co. also employs residents, and Port of Virginia port operations employee locals as well. This industries play a notable role in the community employing people to build ships, facilitate mica production and the loading of cargo onto truck, rail, and barge containers. Moreover, I-664 is an important road for both transporting cargo and facilitating personal travel. However, although these industries and I-664 are important drivers of the Newport News economy, they have costs.

The air quality in Newport News pays the price for emissions from port operations, Newport News Shipbuilding, the Mica Co., and I-664—ultimately affecting the health and quality of life of Newport News residents. Yet there are tools available to help Newport News residents assess their air quality and make informed decisions about future community development.

For example, Newport News community members can use accessible models such as C-PORT to create “What-if” scenarios and see how changes in various industries and entities will affect their air quality. Ultimately, this will allow them to know where they need to concentrate their assets and what they need to change.

The Newport News community can also take cues from other communities that have made changes to make their communities healthier and better for the environment. As mentioned previously, the port of Los Angeles and Long Beach has taken a number of steps to make its air cleaner, but it has also enhanced recreational development with the addition of bike paths, recreational beaches, and museums, making for a more beautiful city with a higher quality of life. If communities as large as these can come together to create positive change in their communities, it is possible for positive change in air quality in Newport News, VA with the hope that resources such as this report will assist in this process.
XI. APPENDIX

Baseline Maps
Maps of Concentration Levels after Widening of I-664 Scenario

PM 2.5 Concentration After Widening I-664
Winter, Stable Conditions, AM Peak Time

NOx Concentration After Widening I-664
Winter, Stable Conditions, AM Peak Time

EC2.5 Concentrations as a Result of I-664 Widening
Winter, Stable Conditions, AM Peak Time

Carbon Monoxide Concentrations after Widening of I-664
Winter, Stable Conditions, AM Peak Time

Benzene Concentration After Widening I-664
Winter, Stable Conditions, AM Peak Time
Maps of Concentration Levels after Craney Island Expansion Scenario

Benzene Concentration After Building Craney Island Terminal Winter, Stable Conditions, AM Peak Time

CO Concentration for Craney Island

NOx Concentration After Building Craney Island Terminal Winter, Stable Conditions, AM Peak Time

PM 2.5 Concentration After Building Craney Island Terminal Winter, Stable Conditions, AM Peak Time

EC 2.5 Concentration for Craney Island

Legend

Particulate Matter

Legend

Log [EC 2.5] for Craney Island

Log [NOx] for Craney Island

Legend

Log [CO] for Craney Island

Legend

Log [Benzene] for Craney Island

Legend

PM 2.5 concentration (microgram/m^3)

EC 2.5 concentration (microgram/m^3)
XII. WORKS CITED


http://www.airnow.gov/index.cfm?action=school_flag_program.index


http://www.atsdr.cdc.gov/phs/phs.asp?id=46&tid=15


http://www.atsdr.cdc.gov/phs/phs.asp?id=159&tid=29


OSHA: Occupational Safety & Health Administration (n.d.) General Hazard: Respiratory Irritation and Systemic Poisoning. Retrieved from
https://www.osha.gov/SLTC/shipbuildingrepair/welding.html


