



# **Governor's Cancer Research Initiative**

## **Cancer Incidence Report for the Staten Island Study Area**

**Albany, New York**

**August 2019**

## **Executive Summary**

This report summarizes cancer patterns and trends for Staten Island, NY. New York State Department of Health (DOH) researchers investigated Staten Island because the borough had the highest rate of all cancers combined in New York City based on 2011-2015 data. This investigation was conducted as part of [Governor Cuomo's Cancer Research Initiative](#) announced in October 2017, which examined cancer trends and the potential causes of cancer in four regions of the state that have higher cancer rates, based on 2011-2015 data.

During the Staten Island Investigation, DOH obtained input from interested members of the community. Researchers met with community members to present the design, goals, and approaches. Community members and stakeholders provided input at meetings and emailed additional feedback.

DOH will use these findings to work with partners to enhance community cancer prevention, recommend appropriate screening efforts, and support access to appropriate high-quality health care.

### ***What was Evaluated***

#### **Cancer Data**

##### Cancer rates

The rate of all cancers combined on Staten Island was 16% higher than that for NYC and 3% higher than that for NYS excluding NYC. When cancer types were evaluated independently, thyroid cancer was the only cancer that stood out as unusually high compared to other areas of New York State. Thus, thyroid cancer was reviewed in further detail using information from the New York State Cancer Registry.

##### Thyroid cancer risk factors

To gain insight into possible factors that may have contributed to the elevated incidence of thyroid cancer on Staten Island, DOH researchers evaluated the literature on the trends, patterns, and risk factors for this disease.

##### Tumor characteristics

DOH researchers reviewed information from the New York State Cancer Registry on the tumor characteristics of the thyroid cancers, such as type of cells that are cancerous and tumor size.

#### **Demographic, Behavioral, Healthcare and Occupational Factors**

DOH researchers reviewed available data about demographic, behavioral, healthcare and occupational factors known to be related to cancer. These included available information about smoking, obesity, and medical care access and practices including diagnostic imaging, surgery, and cancer screening.

## **Environmental Factors**

DOH researchers worked with the Department of Environmental Conservation (DEC) to review available environmental data to look for unusual patterns or trends in the area compared to other areas of New York State. Data included radon concentrations in indoor air, outdoor air pollutants, drinking water contaminants, industrial and inactive hazardous waste disposal sites, and traffic density.

## ***Findings***

### **Cancer Data**

#### Thyroid cancer rates

Thyroid cancer rates on Staten Island were 67% higher than the other four NYC boroughs and 69% higher than NYS excluding NYC. Thyroid cancer is the most common cancer among women aged 20-34 in New York State and on Staten Island, and it is also the most common cancer among women aged 35-39 on Staten Island.

#### Thyroid cancer risk factors

There is strong consensus in the scientific literature that the primary risk factor for thyroid cancer is medical system practices. These include the use of diagnostic imaging, cancer screening, and cancer diagnoses occurring post-surgery.

Increases in thyroid cancer correspond directly to an increase in routine diagnostic imaging – specifically, diagnostic imaging with a neck ultrasound, or another form of imaging in the absence of symptoms. According to an article in the *New England Journal of Medicine*, 70-80% of female thyroid cancer cases and 45% of male thyroid cancer cases diagnosed in the US fall into this category.

#### Tumor characteristics

Papillary carcinoma is the most common type of thyroid cancer in NYS and Staten Island. Papillary carcinoma was responsible for nearly all the increase in cancers on Staten Island and other areas of NYS. This cancer is slow growing and rarely fatal. In addition, nearly all the increase in Staten Island thyroid cancers has been for tumors small enough to be considered subclinical, meaning they were small enough to cause no symptoms.

## **Demographic, Behavioral, Healthcare and Occupational Factors**

### Demographics

While Staten Island is one of the five boroughs of NYC, its demographic makeup more closely resembles areas outside of the NYC area (NYS excluding NYC). Because of this, researchers used NYS excluding NYC as the appropriate comparison area for cancer analyses. Specifically, Staten Island has smaller proportions of Asians, Hispanics, and foreign-born people of all races and ethnicities than the other four boroughs of NYC. These races, ethnicities, and national origin

categories tend to have substantially lower cancer rates than native-born non-Hispanic whites and blacks.

### Smoking

Many cancers are known to be smoking-related, although thyroid cancer is not one of them. Most smoking-related cancer deaths are associated with lung, larynx, bladder, esophageal, and oral cavity cancers. None of these cancers were shown to be significantly elevated compared to other areas of the state. In addition, smoking rates on Staten Island are generally below those of NYS excluding NYC.

### Obesity

Obesity is associated with some cancers and is weakly associated with thyroid cancer. According to a phone survey sample conducted by the NYC Department of Health and Mental Hygiene, it is estimated that about 29% of the Staten Island population is obese.<sup>1</sup> Based on this, researchers calculated that obesity could be responsible for about 1% of the thyroid cancers on Staten Island.

### Screening

Researchers attempted to measure the volume of diagnostic imaging in New York and Staten Island, but data were insufficient, particularly for the typical thyroid patient of age 47. The literature shows that screening events can increase local thyroid cancer rates because they identify cancers that are not likely to progress in a way to cause symptoms and where active treatment is not the standard of care. Some people residing on Staten Island have received free thyroid cancer screening at screening events, though no national organizations in the US currently endorse this practice.

### Surgery

Thyroid surgery is performed more frequently on Staten Island than elsewhere. Thyroid surgeries are performed to treat cancer and benign thyroid conditions. In many cases, cancer is discovered after the removed tissue is evaluated. One study found that 26% of thyroid cancers were discovered in this manner. DOH researchers were not able to discern the surgery-diagnosis sequence from NYS's Cancer Registry data, or whether it is different in Staten Island than in other areas of NYS.

### Occupation

Researchers evaluated whether World Trade Center response could have been a factor in elevated cancer incidence. Results showed that the number of first responders, firefighters, rescue, and recovery workers living in Staten Island and involved in the World Trade Center

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<sup>1</sup> This obesity prevalence estimate is based on the New York City Department of Health and Mental Hygiene, 2015, Community Health Profiles 2015: Staten Island Community District. In the remainder of the report, information on obesity was obtained from the New York State Behavioral Risk Factor Surveillance System (BRFSS) to be consistent with data for the rest of the state. The BRFSS estimate of obesity is lower than the Community Health Profiles estimate.

response likely had a very small influence on the higher rates of thyroid and other cancers in the area for the following reasons:

- First responders make up a relatively small percent of the population.
- Most are male, which wouldn't explain similar elevations in thyroid cancer in women.
- Significant elevations in other cancers related to firefighters' occupational exposures were not observed.

## **Environmental Factors**

DOH researchers worked with the Department of Environmental Conservation (DEC) to review available environmental data to look for evidence of unusual environmental exposures in the area compared to other areas of New York State. The findings of that evaluation showed no unusual environmental exposures that could explain the excess in cancer incidence on Staten Island.

### Outdoor air and emissions data

Researchers reviewed air quality monitoring and computer modeled data for air pollutants and air toxics. Results showed that Staten Island has higher or similar risks compared with NYS excluding NYC.

### Radon testing data

Radon is the second leading cause of lung cancer after smoking. Researchers evaluated radon testing frequency and compared average concentrations in Staten Island to the Environmental Protection Agency's (EPA) recommended action level, as well as other areas of the state. This evaluation showed that radon is not a significant environmental exposure on Staten Island. Lung cancer rates are 4% lower in Staten Island compared with NYS excluding NYC.

### Public drinking water testing and compliance data

Researchers reviewed public drinking water data to identify potential drinking water exposures. Staten Island is served by the NYC Water Supply, which is considered one of the highest quality surface water sources in the country. Analysis of monitoring and compliance data identified no significant drinking water exposures.

### Industrial and inactive hazardous waste disposal sites

Researchers reviewed information about existing sites on Staten Island. Staten Island residents also identified adverse health effects from exposures associated with the former Fresh Kills landfill as a concern. Researchers reviewed comprehensive reports from the Agency for Toxic Substances and Disease Registry and the NYC Department of Health and Mental Hygiene. This evaluation showed no information suggesting contamination from Fresh Kills or other sites is causing widespread exposures on Staten Island.

### Traffic

Researchers evaluated the impacts of traffic as part of the outdoor air and emissions data evaluation described above. In addition, researchers assessed available data about how impacts

of traffic pollution compare with other areas of NYS. Staten Island has a higher percentage of people living near higher traffic roads than other areas of NYS, but a lower percentage than in NYC.

### Ionizing radiation

Ionizing radiation exposure is an important risk factor for thyroid cancer, particularly at a young age. According to the literature, ionizing radiation exposure from certain forms of diagnostic imaging (X-rays, CT scans) is a risk factor for many types of cancer. Researchers could not distinguish the effects of radiation exposure from diagnostic imaging versus the effects of more frequent detections of thyroid cancer through the higher use of diagnostic imaging due to local medical care practices.

In addition, researchers considered whether the number of immigrants from Russia, Belarus, and Ukraine to Staten Island might have influenced the rates of thyroid cancer since the 1980s given their possible exposure to the Chernobyl nuclear accident. This evaluation showed more of these immigrants located in Brooklyn, where thyroid cancer rates were 33% percent lower than in Staten Island. This suggests immigration from these countries is not an important factor in the higher thyroid cancer rates in the area.

## ***Conclusions***

- While Staten Island is one of the five boroughs of NYC, its demographic makeup more closely resembles areas outside of the NYC area (NYS excluding NYC). Using the comparison areas of NYS excluding NYC and rest of NYC, thyroid cancer is the only cancer that is significantly elevated, and its excess has public health significance.
- There is strong consensus in the scientific literature that the primary risk factors for thyroid cancer relate to medical system practices. These include the use of diagnostic imaging, cancer screening, and post-surgery thyroid cancer diagnoses. The literature also shows that screening events and overuse of diagnostic imaging can increase local thyroid cancer rates because they identify insignificant cancers where active treatment is not the standard of care. Some people residing on Staten Island have received free thyroid cancer screening at screening events, though no national organizations in the US currently endorse this practice.
- Results from the environmental investigation did not show any unusual environmental exposures that could explain the excess in thyroid cancers on Staten Island.

## ***Recommendations***

The recommendations below are divided into two main sections: 1) recommended actions to address the specific cancer, thyroid cancer, that was elevated in the Staten Island Study Area, and 2) recommended actions to address all cancer types throughout New York State. Many of

the recommended activities are aligned with two existing State plans that address cancer prevention and control, the *New York State 2018-2023 Comprehensive Cancer Control Plan*, and the *New York State Prevention Agenda 2019-2024*.

## **Recommended Actions Based on the Specific Cancer Elevated in the Study Area**

### **Thyroid Cancer Screening**

Recommendation: The U.S. Preventive Services Task Force recommends *against* screening for thyroid cancer in asymptomatic adults. Educate the public and healthcare providers about recommendations *against* thyroid cancer screening in average risk, asymptomatic adults.

### **Radiation from Medical Imaging**

Recommendation: Increase awareness of such programs as NYS’s “Image Gently” and the national “Image Wisely” campaigns that educate physicians and the public about potential radiation exposure from CT scans and X-rays in both children and adults.

## **Recommended Actions to Reduce the Burden of All Cancers Statewide**

Below are highlights of what individuals can do and what DOH and its partner organizations are doing. For more information on activities, by type of organization, that New Yorkers can do to help reduce the burden of cancer, see:

[https://www.health.ny.gov/diseases/cancer/consortium/docs/2018-2023\\_comp\\_cancer\\_control\\_plan.pdf#page=62](https://www.health.ny.gov/diseases/cancer/consortium/docs/2018-2023_comp_cancer_control_plan.pdf#page=62).

### **For All New Yorkers:**

The following are things that all individuals can do to reduce their risk of cancer:

- If you use tobacco, quit. If you don’t use tobacco, don’t start.
- Eat nutritious meals that include fruits, vegetables and whole grains.
- Get moving for at least 30 minutes a day on five or more days each week.
- Use sunscreen, monitor sun exposure and avoid tanning salons.
- Limit alcohol use.
- Get cancer-preventive vaccines such as hepatitis B and HPV.
- Learn your family health history (if possible) and discuss with your healthcare provider whether genetic counseling might be right for you.
- Discuss what cancer screening tests might be right for you with your healthcare provider.
- Test your home for radon.
- For women of child-bearing age, know the benefits of breastfeeding and, if possible, breast-feed infants exclusively for at least the first six months of life.

## **For NYS Department of Health and Partner Organizations:**

**Cancer Surveillance:** The New York State Cancer Registry (NYSCR) was designated by the CDC (Centers for Disease Control and Prevention) as a Registry of Excellence and has achieved Gold-level certification since 1998. In 2018, the NYSCR became a member of the National Cancer Institute's Surveillance, Epidemiology and End Results Program (SEER), the nation's preeminent source of population-based cancer data.

Recommendation: Continue to meet the highest cancer registry standards for timeliness, completeness and quality of data, and make these data available to researchers, clinicians, public health officials, legislators, policymakers, community groups and the public.

**Environmental Health:** DOH's Center for Environmental Health (CEH) works collaboratively with other agencies including the NYS Department of Environmental Conservation, the federal Environmental Protection Agency (EPA), the Centers for Disease Control and Prevention (CDC), and the Agency for Toxic Substance and Disease Registry (ATSDR). CEH programs evaluate health effects associated with environmental exposures, develop policies, and maintain a variety of programs to reduce and eliminate exposures.

Recommendation: Continue to identify and assess potential exposures throughout the state and take action to reduce those exposures. NYS will continue to support programs to promote and maintain clean air, clean water and reduce human exposures to environmental hazards, with particular attention to the needs of environmental justice communities.

Recommendation: Promote awareness of programs and initiatives to reduce environmental hazards in our communities.

**Statewide Initiatives:** The overarching goals of cancer prevention and control efforts in New York State are detailed in two State plans, the *New York State 2018-2023 Comprehensive Cancer Control Plan*, and the *New York State Prevention Agenda 2019-2024*.

Recommendation: Continue to work with partners to implement cancer-related initiatives.

- More details about the NYS Comprehensive Cancer Control Plan can be found at: <https://www.health.ny.gov/diseases/cancer/consortium/index.htm>.
- More details about the NYS Prevention Agenda can be found at: [https://www.health.ny.gov/prevention/prevention\\_agenda/2019-2024/](https://www.health.ny.gov/prevention/prevention_agenda/2019-2024/).

## ***More Information***

More details about the Governor's Cancer Research Initiative and this investigation may be found at [https://www.health.ny.gov/diseases/cancer/cancer\\_research\\_initiative/](https://www.health.ny.gov/diseases/cancer/cancer_research_initiative/).



## Suggested Citation

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[https://health.ny.gov/diseases/cancer/docs/richmond\\_final\\_report\\_2019.pdf](https://health.ny.gov/diseases/cancer/docs/richmond_final_report_2019.pdf).

For questions and comments please send an email to [canmap@health.ny.gov](mailto:canmap@health.ny.gov).

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# Table of Content

Governor's Cancer Research Initiative .....	i
Executive Summary.....	ii
Suggested Citation .....	ix
Acknowledgements.....	ix
Table of Content.....	x
Introduction and Background.....	1
The Governor's Cancer Research Initiative .....	1
Selection of Study Area and Types of Cancers Being Studied.....	1
Approach .....	7
Evaluation of Thyroid Cancer Patterns .....	7
Evaluation of Behavioral, Healthcare and Occupational Factors.....	7
Environmental Data Review .....	7
Findings.....	12
Thyroid Cancer Risk Factors .....	13
Tumor Characteristics .....	13
Behavioral Factors.....	15
Healthcare Factors .....	16
Occupational Factors.....	19
Other Factors.....	20
Environmental Factors .....	21
Limitations.....	28
General Considerations.....	28
Limitations of Data Sources .....	28
Conclusions .....	31
Recommendations .....	33
Recommended Actions Based on Specific Cancers Elevated in the Staten Island Study Area.	33
Recommended Actions to Reduce the Burden of All Cancers Statewide.....	33

References..... 37

Technical Notes ..... 42

Appendix A – Description of data sources..... 43

Appendix B – Long term time trends for criteria air pollutant concentrations for Staten Island  
monitoring locations..... 57

Appendix C – Toxicological information for primary air toxic risk drivers in Staten Island ..... 59

Appendix D – Comparisons of NATA modeled estimates with DEC monitor concentrations for air  
toxics data from Staten Island ..... 65

Appendix E – Summary of industrial and inactive hazardous waste sites for Staten Island ..... 66

# **Introduction and Background**

## ***The Governor's Cancer Research Initiative***

The [Governor's Cancer Research Initiative](#), announced in October 2017, was undertaken to examine cancer trends and the potential causes of cancer in four regions of the state that have a higher incidence of cancer. The four regions are Warren County in northeastern New York, Staten Island (Richmond County) in New York City, an area of East Buffalo and West Cheektowaga in western New York, and an area including the communities of Centereach, Farmingville and Selden on Long Island. As part of the initiative, staff from the New York State Department of Health conducted a detailed review of cancer data for each area. Staff also examined information on demographic, socioeconomic, behavioral and occupational factors that might be contributing to the higher incidence of specific types of cancer. In addition, Department staff worked with the Department of Environmental Conservation to identify potential sources of environmental contaminants that may be affecting cancer rates. The Department will use the results of the initiative to enhance community cancer prevention and screening efforts and support access to appropriate high-quality health care.

Throughout the course of the initiative, the Department received input from interested members of the four communities on potential avenues of investigation and possible sources of the elevated cancer rates. In July 2018, Department staff met with community members and stakeholders in each study area to present the design, goals and approaches for each investigation. At the meetings and afterwards, community members and stakeholders provided input that was taken into account during the investigation.

Cancer is one of the most common chronic diseases in New York State (NYS), and is second only to heart disease as the leading cause of death. Each year, about 110,000 New Yorkers are diagnosed with cancer. It has been estimated that 40 in 100 men and 38 in 100 women will be diagnosed with cancer at some point in their lives.<sup>1</sup> Cancer is not a single disease, but a collection of over 100 different diseases, each with its own occurrence patterns, effective treatments, outlooks and sets of causes. Incidence patterns for different cancers are affected by a number of factors, including those related to sociodemographics, personal behaviors, occupation and the environment. Patterns may also be affected by differences in how cancer is diagnosed across the state or over time. This report seeks to investigate and provide some insight into potential reasons for the higher than expected incidence of certain cancers on Staten Island, based on a review of available data sources.

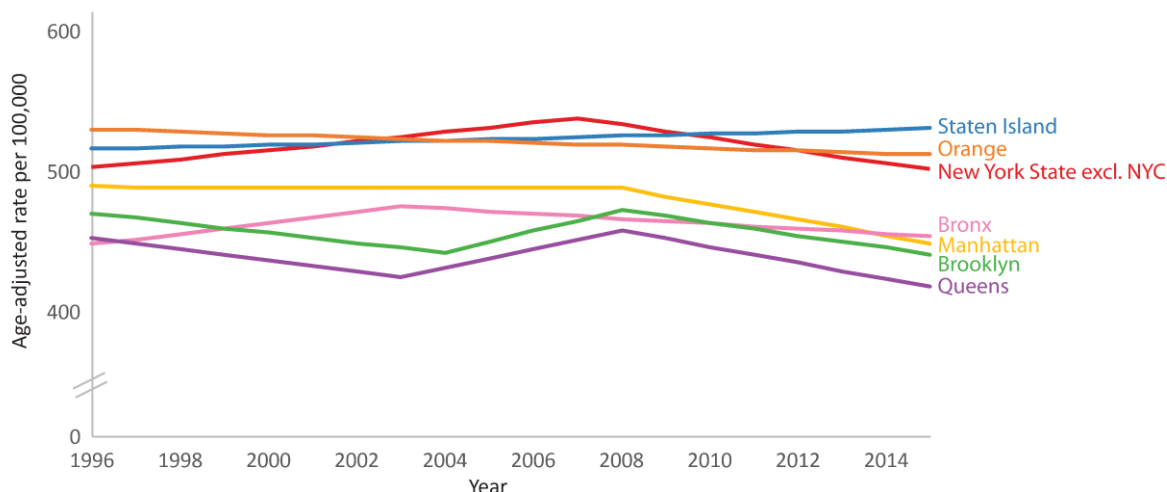
## ***Selection of Study Area and Types of Cancers Being Studied***

Staten Island was chosen as a study area because it had the highest incidence rate for all cancers combined among the five New York City (NYC) boroughs for the years 2011-2015. The objective of this report is to summarize cancer patterns and trends for Staten Island and how they compare with cancer rates elsewhere in New York State.

For the five-year period from 2011 to 2015, the age-adjusted cancer rate for all invasive cancers combined on Staten Island was 524.9 per 100,000. This figure is 7% higher than the rate for New York State as a whole, 16% higher than the rate for New York City, and 3% higher than the rate for New York State excluding New York City (NYS excluding NYC). There were 13 counties with rates higher than Staten Island and 48 counties with rates lower than Staten Island. The rates on Staten Island were the highest of the five New York City boroughs.

Staten Island has generally had the highest overall age-adjusted cancer rate among the five boroughs of New York City dating back to 1976, the first year for which statewide population-based cancer data are available for New York State. Over the last two decades, Staten Island's cancer rate has generally stayed between 500 and 550 per hundred thousand, while the other boroughs have been in the range of 420 to 500 per hundred thousand. Figure 1 shows smoothed rates for Staten Island, the other four boroughs of New York City, Orange County, and the rest of New York State.

**Figure 1. Smoothed age-adjusted cancer incidence rates, all cancers combined, Staten Island and comparison areas, 1996-2015. Details of the data smoothing method used are in the technical notes.**



New York State excluding New York City and Orange County are shown because they are demographically more similar to Staten Island than the other four boroughs of New York City and represent a more appropriate comparison population. Socioeconomic status and race/ethnic composition tend to explain much of the geographic variation in cancer incidence and so must be considered when determining whether the cancer rates in an area are unusual. According to the United States Census Bureau's American Community Survey, in the 2011-2015 period Staten Island averaged 472,000 people (10<sup>th</sup> among counties in the state), a median household income of \$73,000 (6<sup>th</sup>) and 36% minority population (7<sup>th</sup>, where minorities comprise Hispanic, black, Asian, and American Indians). The most similar counties are the lower Hudson Valley counties of Orange, Rockland, Dutchess, and Westchester, with Orange the most similar: a population of 375,000 (12<sup>th</sup>), median household income of \$70,848 (10<sup>th</sup>), and 32%

minority population (9<sup>th</sup>). Staten Island is entirely urban while the Lower Hudson counties are a mix of urban, suburban and some rural areas, but population density is not an important influence on overall cancer risk. Notably, the overall cancer rates for Orange County in Figure 1 are closer to those of Staten Island than the rates for New York State excluding New York City. Also, averaged over the past 20 years, Staten Island's overall cancer rates have been just 1% higher than those for New York State excluding New York City.

Cancer rates in Manhattan, the Bronx, Brooklyn and Queens tend to be lower than those in Staten Island, and those in the rest of New York State, because these boroughs have much larger proportions of Asians, Hispanics, and foreign-born persons – all groups with substantially lower cancer risks, largely believed to be related to diet, lower smoking rates, and other behavioral factors.<sup>2-4</sup>

Individual types of cancer are of greater interest than all types of cancer combined. Among the 17 most common types of cancer, only one, thyroid cancer, stood out as being unusually high on Staten Island. Rates of thyroid cancer on Staten Island were 67% higher than the other four boroughs of New York City, 69% higher than New York excluding New York City, and 36% higher than Orange County (Table 1a). Thyroid cancer rates were similarly high among both males and females (Tables 1b and 1c). No other sites showed a similar elevated pattern.

For the purposes of this cancer investigation, a cancer type was considered for detailed review if it met the following criteria:

- 1) The incidence rate for the cancer type on Staten Island was higher than both the rates for the other four boroughs combined and for New York State excluding New York City. If this were not the case, it would have been appropriate to study the area that had the higher rates, not Staten Island.
- 2) The elevated incidence rate was statistically significant. Otherwise, the elevation may have been due to chance fluctuations in the data rather than any attributable cause.
- 3) The elevated incidence rate had public health significance. This means that an elevation must be high enough that it warrants targeted public health intervention. This explains why colorectal cancer and corpus uteri cancer were not selected for study, since the rates between Staten Island and the comparison areas are below 20 percent. In addition, the New York State Environmental Facilities and Cancer Mapping website ([https://apps.health.ny.gov/statistics/cancer/environmental\\_facilities/mapping/map/](https://apps.health.ny.gov/statistics/cancer/environmental_facilities/mapping/map/)) identifies other areas where colorectal cancer incidence rates are elevated by at least 50%. These would be more appropriate locations to focus on colorectal cancer risk than Staten Island.

Based on the data summarized in Tables 1a, 1b and 1c, thyroid cancer was the only cancer type that met the criteria outlined above, thus thyroid cancer was reviewed in further detail.

**Table 1a. Cancer rates for Staten Island, the rest of New York City, New York State excluding New York City, and Orange County, 2011-2015, both sexes combined. Rates are per 100,000 and age-adjusted to the 2000 US Standard population (19 age groups-Census P25-1130) standard. CI: Confidence interval. \*Statistically significantly higher +Statistically significantly lower.**

Both sexes combined	Rate (95% CI)				Percent difference		
	Staten Island	Other 4 Boroughs	NYS excl. NYC	Orange County	Other 4 Boroughs	NYS excl. NYC	Orange County
All Sites	524.9 (516.1-533.8)	448.7 (446.7-450.8)	511.3 (509.6-513.1)	505.9 (495.7-516.2)	17.0*	2.7*	3.8
Oral Cavity and Pharynx	10.0 (8.8-11.3)	9.7 (9.4-10.0)	11.4 (11.1-11.6)	10.2 (8.8-11.7)	3.2	-12.1 <sup>+</sup>	-2.0
Esophagus	3.3 (2.6-4.0)	3.6 (3.5-3.8)	5.1 (5.0-5.3)	4.9 (4.0-6.0)	-10.6	-36.6 <sup>+</sup>	-33.8 <sup>+</sup>
Stomach	8.3 (7.2-9.5)	11.2 (10.8-11.5)	7.3 (7.1-7.5)	7.3 (6.2-8.7)	-25.6 <sup>+</sup>	13.4	13.4
Colon and Rectum	43.3 (40.8-45.9)	40.0 (39.3-40.6)	39.6 (39.1-40.1)	41.5 (38.6-44.5)	8.4*	9.3*	4.5
Liver and IBD	10.5 (9.4-11.8)	11.5 (11.2-11.8)	7.1 (6.9-7.3)	9.9 (8.6-11.4)	-8.2	48.3*	6.4
Pancreas	13.7 (12.3-15.2)	13.7 (13.3-14.0)	14.2 (13.9-14.5)	14.2 (12.5-16.0)	0.4	-3.3	-3.1
Larynx	4.1 (3.3-4.9)	3.1 (2.9-3.3)	3.5 (3.3-3.6)	4.3 (3.4-5.4)	31.0*	17.0	-6.1
Lung and Bronchus	64.7 (61.7-67.9)	47.9 (47.2-48.6)	67.2 (66.6-67.9)	66.6 (62.9-70.5)	35.2*	-3.7	-2.8
Melanoma of the Skin	18.0 (16.4-19.7)	10.0 (9.7-10.4)	23.2 (22.9-23.6)	20.0 (18.0-22.1)	79.2*	-22.6 <sup>+</sup>	-10.1
Urinary Bladder	26.0 (24.1-28.1)	16.6 (16.2-17.0)	27.3 (26.9-27.7)	26.3 (24.0-28.8)	56.9*	-4.7	-1.0
Kidney and Renal Pelvis	18.9 (17.2-20.6)	13.9 (13.5-14.3)	18.0 (17.6-18.3)	18.7 (16.8-20.7)	35.7*	5.1	1.1
Brain and Other Nervous System	6.8 (5.8-8)	5.7 (5.5-6.0)	7.2 (7.0-7.4)	6.3 (5.2-7.5)	19.3*	-4.8	8.8
Thyroid	33.2 (30.9-35.5)	19.9 (19.4-20.3)	19.6 (19.2-19.9)	24.5 (22.2-26.9)	66.9*	69.5*	35.6*
Hodgkin Lymphoma	3.9 (3.2-4.8)	3.1 (2.9-3.3)	3.3 (3.2-3.5)	3.2 (2.4-4.1)	25.5*	17.7	23.2
Non-Hodgkin Lymphoma	24.1 (22.3-26.1)	19.9 (19.4-20.3)	22.4 (22.1-22.8)	22.3 (20.2-24.5)	21.6*	7.7	8.5
Myeloma	8.8 (7.7-10)	8.9 (8.6-9.2)	7.5 (7.3-7.7)	8.3 (7.0-9.7)	-1.2	17.0*	5.9
Leukemia	18.5 (16.9-20.3)	13.6 (13.3-14.0)	17.9 (17.6-18.2)	15.4 (13.7-17.4)	35.6*	3.3	19.8*

**Table 1b. Cancer rates for Staten Island, the rest of New York City, New York State excluding New York City, and Orange County, 2011-2015, males. Rates are per 100,000 and age-adjusted to the 2000 US Standard population (19 age groups-Census P25-1130) standard. CI: Confidence interval. \*Statistically significantly higher +Statistically significantly lower.**

Males	Rate (95% CI)				Percent difference		
	Staten Island	Other 4 Boroughs	NYS excl. NYC	Orange County	Other 4 Boroughs	NYS excl. NYC	Orange County
All Sites	577.1 (563.2-591.2)	504.5 (501.1-507.8)	561.1 (558.4-563.8)	544.9 (529.1-561.0)	14.4*	2.9*	5.9*
Oral Cavity and Pharynx	14.9 (12.8-17.2)	14.5 (13.9-15.1)	17.0 (16.6-17.5)	17.0 (14.4-20.0)	2.7	-12.6	-12.5
Esophagus	5.9 (4.6-7.5)	6.1 (5.7-6.5)	8.7 (8.4-9.1)	8.3 (6.5-10.5)	-3.4	-32.5+	-29.2
Stomach	10.6 (8.7-12.7)	15.3 (14.7-15.9)	10.3 (9.9-10.7)	9.9 (7.9-12.4)	-30.9+	2.5	6.4
Colon and Rectum	49.4 (45.3-53.7)	47.6 (46.5-48.6)	45.0 (44.2-45.7)	46.0 (41.4-50.9)	3.9	9.8*	7.4
Liver and IBD	17.0 (14.7-19.4)	18.2 (17.5-18.8)	11.0 (10.7-11.4)	14.7 (12.2-17.4)	-6.5	53.8*	15.8
Pancreas	15.8 (13.6-18.3)	15.5 (14.9-16.2)	16.1 (15.7-16.6)	14.4 (12-17.2)	1.9	-1.9	10.0
Larynx	7.1 (5.6-8.8)	5.8 (5.5-6.2)	6.0 (5.7-6.3)	8.0 (6.1-10.2)	21.7	17.9	-11.2
Lung and Bronchus	76.1 (71.1-81.4)	58.5 (57.4-59.7)	74.5 (73.6-75.5)	74.5 (68.6-80.8)	30.0*	2.1	2.2
Melanoma of the Skin	23.1 (20.4-26.2)	13.0 (12.4-13.5)	29.2 (28.6-29.8)	26.1 (22.8-29.8)	78.6*	-20.7+	-11.4
Prostate	125.4 (119.2-131.9)	135.5 (133.8-137.2)	129.8 (128.6-131.1)	121.9 (114.7-129.3)	-7.4+	-3.4	2.9
Testis	6.3 (4.9-8)	4.6 (4.3-4.9)	6.9 (6.5-7.2)	7.3 (5.6-9.3)	37.3*	-7.9	-13.0
Urinary Bladder	47.7 (43.7-52)	29.9 (29.0-30.7)	46.9 (46.1-47.7)	45.6 (40.9-50.6)	59.8*	1.7	4.6
Kidney and Renal Pelvis	27.2 (24.3-30.3)	19.9 (19.2-20.5)	25.0 (24.4-25.6)	24.9 (21.7-28.4)	36.7*	8.7	9.3
Brain and Other Nervous System	7.7 (6.1-9.5)	6.8 (6.4-7.2)	8.3 (8.0-8.7)	7.9 (6.1-10.0)	12.9	-8.1	-3.1
Thyroid	18.3 (16.0-21.0)	9.6 (9.2-10.1)	10.3 (10.0-10.7)	11.9 (9.7-14.4)	90.3*	77.4*	54.3*
Hodgkin Lymphoma	4.1 (3.0-5.5)	3.5 (3.3-3.8)	3.7 (3.5-4.0)	4.0 (2.8-5.6)	17.1	10.7	2.9
Non-Hodgkin Lymphoma	28.9 (25.8-32.3)	24.4 (23.7-25.2)	27.4 (26.8-28.0)	27.6 (24.2-31.4)	18.3*	5.6	4.7
Myeloma	12.3 (10.3-14.6)	10.9 (10.4-11.4)	9.3 (8.9-9.6)	9.8 (7.7-12.2)	13.3	32.7*	26.2
Leukemia	23.3 (20.5-26.3)	17.5 (16.9-18.2)	23.2 (22.7-23.8)	20.6 (17.6-24.1)	32.9*	0.1	12.7



**Table 1c. Cancer rates for Staten Island, the rest of New York City, New York State excluding New York City, and Orange County, 2011-2015, females. Rates are per 100,000 and age-adjusted to the 2000 US Standard population (19 age groups-Census P25-1130) standard. CI: Confidence interval. \*Statistically significantly higher +Statistically significantly lower.**

Females	Rate (95% CI)				Percent difference		
	Staten Island	Other 4 Boroughs	NYS excl. NYC	Orange County	Other 4 Boroughs	NYS excl. NYC	Orange County
All Sites	491.5 (479.9-503.2)	415.0 (412.4-417.7)	478.8 (476.4-481.1)	483.1 (469.6-497.0)	18.4*	2.7*	1.7
Oral Cavity and Pharynx	6.0 (4.8-7.4)	5.9 (5.6-6.3)	6.5 (6.2-6.7)	4.4 (3.2-5.9)	0.9	-7.4	36.2
Esophagus	1.2 (0.7-1.9)	1.8 (1.7-2.0)	2.1 (2.0-2.3)	2.1 (1.3-3.2)	-35.7	-44.8*	-42.6
Stomach	6.5 (5.3-8.0)	8.2 (7.8-8.6)	5.0 (4.7-5.2)	5.3 (4.0-6.9)	-20.7*	30.9*	23.8
Colon and Rectum	38.2 (35.1-41.6)	34.4 (33.7-35.2)	35.2 (34.6-35.8)	38.2 (34.4-42.2)	11.1*	8.6	0.2
Liver and IBD	5.3 (4.2-6.6)	6.2 (5.9-6.5)	3.7 (3.5-3.9)	5.9 (4.5-7.6)	-15.2	41.2*	-11.0
Pancreas	12.0 (10.3-13.9)	12.3 (11.8-12.7)	12.5 (12.2-12.9)	13.8 (11.6-16.2)	-2.1	-4.4	-12.9
Larynx	1.7 (1.1-2.6)	1.1 (0.9-1.2)	1.4 (1.2-1.5)	1.5 (0.9-2.5)	59.8*	25.8	13.0
Lung and Bronchus	56.5 (52.7-60.5)	40.7 (39.9-41.6)	62.2 (61.4-63.0)	60.8 (56.1-65.8)	38.8*	-9.1*	-7.0
Melanoma of the Skin	14.6 (12.6-16.7)	8.2 (7.8-8.5)	19.0 (18.6-19.5)	15.3 (12.9-17.9)	78.6*	-23.5*	-4.5
Breast	134.8 (128.8-141)	120.3 (118.9-121.8)	138.1 (136.8-139.3)	131.8 (124.7-139.1)	12.1*	-2.4	2.3
Cervix Uteri	7.4 (5.9-9.0)	9.2 (8.8-9.6)	6.7 (6.4-7.1)	8.4 (6.6-10.6)	-20.2*	9.0	-12.8
Corpus uterus and NOS	35.4 (32.4-38.6)	30.4 (29.7-31.2)	31.9 (31.4-32.5)	34.9 (31.4-38.6)	16.3*	10.8*	1.5
Ovary	12.8 (11.0-14.8)	11.9 (11.5-12.4)	12.6 (12.3-13.0)	12.5 (10.4-14.9)	7.2	1.2	2.2
Urinary Bladder	10.1 (8.5-11.9)	7.6 (7.3-8.0)	12.5 (12.1-12.8)	11.8 (9.8-14.1)	32.0*	-19.0*	-14.8
Kidney and Renal Pelvis	11.8 (10.1-13.8)	9.2 (8.8-9.6)	11.9 (11.6-12.3)	13.2 (11.0-15.7)	28.1*	-0.8	-10.3
Brain and Other Nervous System	6.1 (4.8-7.6)	4.9 (4.6-5.2)	6.2 (5.9-6.4)	4.9 (3.6-6.6)	25.7	-1.0	24.1
Thyroid	47.0 (43.2-50.9)	29.0 (28.3-29.7)	28.6 (28.0-29.3)	37.0 (33.2-41.3)	61.9*	64.1*	26.8*
Hodgkin Lymphoma	3.7 (2.7-5.0)	2.8 (2.5-3.0)	2.9 (2.7-3.2)	2.4 (1.5-3.7)	34.6	26.2	52.3
Non-Hodgkin Lymphoma	20.5 (18.2-23)	16.4 (15.9-16.9)	18.4 (18.0-18.9)	17.8 (15.3-20.7)	24.8*	10.9	14.8
Myeloma	6.1 (4.9-7.5)	7.5 (7.1-7.8)	6.1 (5.8-6.4)	7.2 (5.6-9)	-18.5	0.1	-15.2
Leukemia	15.3 (13.3-17.6)	10.9 (10.5-11.4)	13.7 (13.3-14.1)	11.6 (9.5-13.9)	40.6*	11.8	32.8*

## **Approach**

To gain insight into possible factors that may have contributed to the elevated incidence of thyroid cancer on Staten Island, we evaluated the literature on the trends, patterns, and risk factors of this disease. We also reviewed and analyzed a number of data sources to gather information for this report. A summary of those data sources can be found in Appendix A.

### ***Evaluation of Thyroid Cancer Patterns***

To gain insight into possible factors that may be contributing to the elevated incidence of the thyroid cancer in Staten Island, we reviewed detailed information from the New York State Cancer Registry. The New York State Cancer Registry is a population-based cancer incidence registry responsible for the collection of demographic, diagnostic and treatment information on all patients diagnosed with and/or treated for cancer at hospitals, laboratories and other health care facilities throughout New York State. Submission of data is mandated under New York State Public Health Law, section 2401. The Cancer Registry collects a wide variety of information that can be used for research and public health planning and evaluation. Cancer Registry data are routinely used by programs within the Department of Health, county and local health departments, patient advocacy groups, public interest groups, researchers and the public. Because the Cancer Registry has collected statewide data since 1976, it can be used to monitor cancer incidence patterns and trends for all areas of New York State. More information is available on its web page: <http://www.health.ny.gov/statistics/cancer/registry/about.htm>.

### ***Evaluation of Behavioral, Healthcare and Occupational Factors***

Following the review of cancer data, possible cancer risk factors on the community or population level were assessed. These include lifestyle factors such as smoking, the prevalence of various medical conditions and treatments, indicators of medical care practices in the community, occupations of community residents, and potential environmental exposures. Existing data sources on these risk factors were examined, including the Behavioral Risk Factor Surveillance Survey funded by the Centers for Disease Control and Prevention, the American Community Survey conducted by the U.S. Bureau of the Census, New York City's Community Health Profiles, the New York State hospital inpatient and outpatient discharge data (SPARCS), and claims data from New York State Medicaid and Medicare patients. More information on these data sources can be found in Appendix A.

### ***Environmental Data Review***

#### **Overview**

To assess whether residents of Staten Island have a history of unusual environmental hazards and potential exposures in comparison to NYS excluding NYC and/or NYS as a whole, extensive reviews of available data were conducted by staff from the NYS Department of Health (DOH)

and NYS Department of Environmental Conservation (DEC). These evaluations focused on 1) outdoor air pollution, 2) radon in indoor air, 3) drinking water quality from community water systems, and 4) remedial sites on Staten Island. In addition, DOH staff also explored specific environmental concerns raised by community members such as pesticide use and local industrial activities.

## **Outdoor Air Quality**

New York State began developing air pollution control programs over 60 years ago with enactment of the nation's first comprehensive air pollution control laws in 1957 (Air Pollution Control Act, formerly Article 12-A of the Public Health Law). At the federal level, with the 1970 Clean Air Act, the US Environmental Protection Agency (USEPA) began regulating criteria air pollutants which include carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, ozone, and lead, through the National Ambient Air Quality Standards (NAAQS) program. In 1990, the Clean Air Act was amended to include a list of hazardous air pollutants selected by Congress based on potential health and environmental hazards. The original list included 188 hazardous air pollutants (HAPs) such as benzene, which is found in gasoline; tetrachloroethene (PERC), which is emitted from dry cleaning facilities; methylene chloride, which is used as a solvent and paint stripper; and some metals such as cadmium, mercury, and chromium. These federal and state air pollution control programs are associated with a variety of air pollutant data collection and model estimation systems that have evolved over time. The following data sources were used in this evaluation to provide indicators of current and historical air quality on Staten Island as well as in NYS more generally: 1) The US Environmental Protection Agency's (USEPA) Air Quality System database, and 2) USEPA'S National-scale Air Toxics Assessment (NATA) data.

The USEPA's Air Quality System database contains data from air quality monitoring stations across NYS at various locations and timeframes since 1965. This database currently includes sulfur dioxide, ozone, carbon monoxide, nitrogen dioxide, and lead, total suspended particulates and particulate matter less than 2.5 and 10 microns (PM<sub>2.5</sub> & PM<sub>10</sub>) in diameter. Although toxicological data do not indicate that these criteria air pollutants are environmental risk factors for cancer, they were evaluated since they provide the longest historical measurements of air pollution. DEC operates a statewide Air Toxics Monitoring Network that measures air pollutants that are known or likely human carcinogens. The database contains measurements for criteria pollutants as far back as early 1965 and toxic air pollutants starting in the late 1980s.

This evaluation also reviewed data on hazardous air pollutants (HAPS), including known or likely human carcinogens, from the 2011 and 2014 National-scale Air Toxics Assessment program (NATA) data. The number of USEPA-designated HAPs included in the model has varied from 32 in 1996 to 180 plus diesel particulate matter in 2014. The selected HAPs were those considered known or likely human carcinogens based on authoritative review by agencies such as the International Agency for Research on Cancer (IACR), US Environmental Protection Agency's Integrated Risk Information System (USEPA IRIS), and US Department of Health and Human

Services' National Toxicology Program (USDHHS NTP). The emissions data used to model air pollutant levels come from state sources, the Toxic Release Inventory, the National Emissions Inventory, and other databases, and are most comprehensive for the years 2011 and 2014. USEPA developed outdoor air concentration estimates using a complex computer program called a dispersion model that merges the emissions data with meteorological data, such as wind speed and wind direction, to estimate pollutant concentrations in ambient air. This modeling accounted for emissions from large industrial facilities, such as power plants and manufacturing facilities; smaller facilities, such as dry cleaners and gas stations; mobile sources such as motor vehicles, trains, planes/airports, ports and boats; and farming and construction equipment. USEPA also accounted for secondary formation of pollutants through photochemical mechanisms and pollution due to residential wood burning, wildfires, agricultural burning, and structural fires. Additional details about all these data sources can be found in Appendix A.

## **Radon in Indoor Air**

Radon is present everywhere, but some areas are at a higher risk due to their underlying geology. Radon in homes is the largest source of radiation exposure to the general public. According to the aero-radioactivity maps produced by US Geological Survey (USGS), certain regions in NYS, including the Reading Prong and the Inner Gulf Coastal Plain, showed high levels of uranium and radon decay products. Although these areas stretch over a few counties in NYS, the high radon levels in several adjacent counties could be a result of the radioactivity resulting from the uranium-rich geological structures. Measurements of radon in New York State homes made since 1985 have identified many areas with elevated indoor radon levels. Forty-one of the sixty-two NYS counties show average indoor basement-level radon concentrations greater than 4 picocuries per liter of air (pCi/L) and are considered as "high-risk" radon counties. Staten Island is not among these counties.

For this evaluation, the DOH sought to characterize radon test results from 1987 to 2015. Researchers used radon data from tests conducted during this period (excluding tests performed at schools and day care centers), to estimate various measures for the Staten Island study area and comparison areas including New York State (NYS), New York City (NYC), and NYS excluding NYC. The summary measures of radon test results evaluated for each study and comparison area include: total number of tests conducted, average and maximum test values and percent of tests that were at or above the action level of 4 pCi/L. We also determined number of tests and average radon values by floor level (basement and first floor) in each of the areas. DOH staff also prepared a map for the study area to display average radon levels by census block. See Appendix A for more information about the data sources evaluated.

## **Drinking Water Quality**

This review evaluated drinking water data associated with regulatory activities and routine sampling conducted for community water supplies. The DOH and the federal government regulate public drinking water systems. In 1974, Congress passed the Safe Drinking Water Act

that standardized the protection of drinking water on a national level. States that previously had established drinking water standards were required to make their standards at least as stringent as the national standards promulgated by the USEPA. These national drinking water standards first went into effect in 1977.

The list of regulated analytes has evolved over time and includes a variety of principal organic compounds (POCs), metals, pesticides, pathogens, and other contaminants. For regulated analytes, Maximum Contaminant Levels have been established. A violation of a regulation occurs when the established Maximum Contaminant Level (MCL) is surpassed. In certain cases, an MCL is defined as a running average of samples over a quarterly time frame. This means an individual exceedance of an MCL in one sample may not warrant a violation. Rather, an exceedance occurring over a certain time frame that reaches an average value above that of the Maximum Contaminant Level would trigger a violation.

This review evaluated sampling data for finished water at entry points to the distribution system. Staff reviewed exceedances and violations. In cases where violations were issued, details about the violations are provided. Recent data for some contaminants that are currently unregulated were also evaluated. Additional information about the data sources for drinking water sample data can be found in Appendix A.

## **Industrial and Inactive Hazardous Waste Disposal Sites**

DEC and DOH each have a role in managing contaminated sites and preventing and/or minimizing human exposures to site-related contaminants. The mission of the DEC's Division of Environmental Remediation is to protect public health and the environment of the State of New York by: preventing releases to the environment through the regulation of petroleum and chemical bulk storage facilities, hazardous waste facilities, and radiation facilities; and responding to, investigating, and remediating releases of contaminants that have occurred. DOH staff work with DEC staff to investigate the potential for human exposure to site-related environmental contamination, primarily at inactive hazardous waste sites and brownfield sites. For every state, federal superfund, brownfield, and voluntary clean-up site, a specialist is assigned to coordinate and communicate health-related activities. In addition, staff prepare public health assessments for federal superfund sites under an agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

DOH and DEC staff developed an inventory of inactive hazardous waste sites and brownfields sites for Staten Island. Area residents who participated in public meetings also identified sites of concern. DOH evaluated the available information to determine whether people were exposed to any contaminants released from these sites. More information can be found in Appendix A.

## **Traffic**

Members of the community also had concerns about impacts of traffic pollution in the study area. Air pollution from mobile sources is one of the emission sources included in EPA's

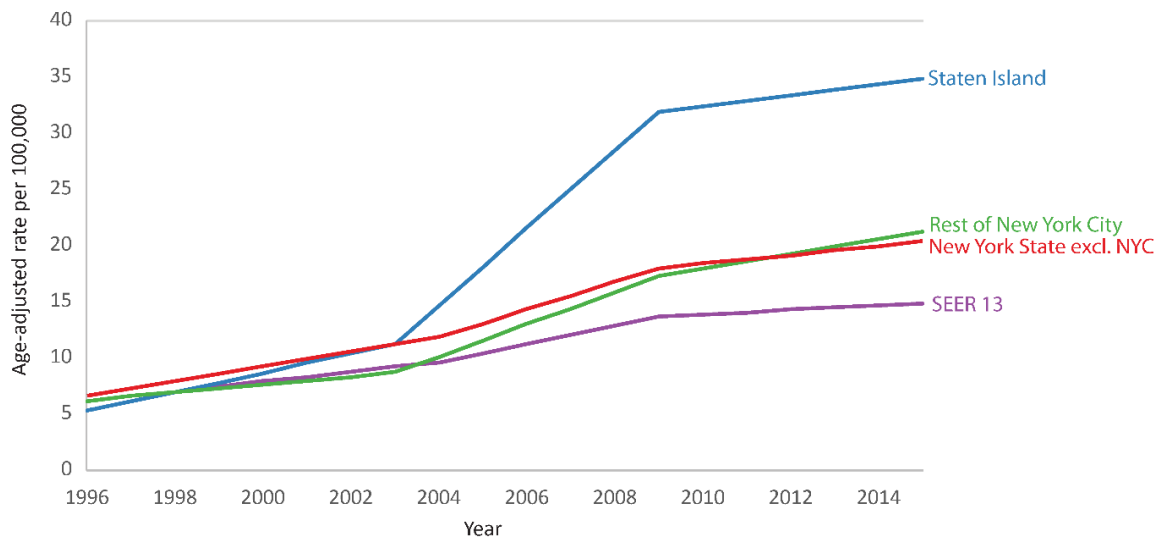
National Scale Air Toxics Assessment (see Outdoor Air Quality). DOH researchers reviewed information from the NYS Department of Transportation (DOT) traffic monitoring program. This program collects information on traffic counts at fixed and temporary monitoring locations. DOH used this data to assess how traffic in the study area compares to traffic in other areas of New York State. This information was used to create average annual daily counts of traffic for road segments along interstate highways and all New York State routes and roads that are part of the Federal Aid System.

## Findings

Thyroid cancer has been on the rise in virtually every developed country for decades, regardless of demographics, environment, or type of health care system. It is on pace to be the fourth most common cancer globally by 2030.<sup>5</sup> Thyroid cancer is primarily a disease of women, with age-adjusted rates close to 3 times higher among women than men. For women, it is also a disease of middle age, with peak rates in the United States occurring among the 50-54 age group. For men, the age peak is at age 70-74.<sup>6</sup>

In the 1990s, the rates of thyroid cancer on Staten Island, the rest of New York City, New York State excluding New York City, and the United States were similar and increasing by a similar amount (Figure 2). Beginning in 2003, rates on Staten Island began to increase much more rapidly than the rest of New York. Since 2008, rates have resumed increasing at about the same rate and the gap between Staten Island and the rest of New York has remained constant.

**Figure 2. Smoothed age-adjusted thyroid cancer incidence rates, Staten Island and comparison areas, 1996-2015. “SEER 13” refers to 13 states and cities belonging to the SEER program of the National Cancer Institute, which is a proxy for national rates. Details of the data smoothing method are in the technical notes.**



The consequence of these trends is that, as seen in Table 1a, Staten Island has thyroid cancer rates that are nearly 70% higher than the rest of New York State. The overall rate in Staten Island exceeded that of Putnam County, the second highest county, by 17%, and third-ranked Warren County by 30%.

Thyroid cancer is the most common cancer among women aged 20-34 in New York State; on Staten Island it is also the most common cancer for women aged 35-39, an age group where breast cancer is typically more common. Between 2011 and 2015, the rates of breast cancer and thyroid cancer among women aged 35-39 in New York State excluding New York City were 71 and 46 per 100,000, respectively. On Staten Island these rates were 57 and 71 – nearly

reversed, a striking and unusual pattern. Beginning at age 40, breast cancer rates surpass those of thyroid cancer by a large margin in all locations.

## ***Thyroid Cancer Risk Factors***

There is a strong consensus in the scientific literature that the primary risk factor for thyroid cancer at present is the medical system itself – specifically, the provision of a neck ultrasound or other form of imaging in the absence of any symptoms or expectation of future symptoms.<sup>5,7,8</sup> An recent analysis published in the *New England Journal of Medicine* estimated that 70 to 80 percent of female thyroid cancer cases and 45 percent of male thyroid cases in the United States fall into this category.<sup>7</sup>

The next most important modifiable risk factor for thyroid cancer is exposure to ionizing radiation,<sup>9-10</sup> particularly at a young age.<sup>11-13</sup> Medical imaging in the form of x-rays and CT scans is a major source of radiation exposure and so this risk factor overlaps with the first.<sup>11,14,15</sup> Other sources of radiation exposure include treatment for a previous cancer,<sup>16</sup> emissions from nuclear accidents,<sup>12,17</sup> and fallout from above-ground nuclear weapons testing.<sup>10,18</sup> There is also evidence that a diet low in iodine is associated with increased risk of the follicular subtype of thyroid cancer.<sup>19</sup>

Non-modifiable risk factors for thyroid cancer include hereditary conditions such as mutations in the *RET* gene,<sup>20,21</sup> familial adenomatous polyposis,<sup>22,23</sup> Cowden disease,<sup>22-24</sup> and Carney complex type I.<sup>22,23</sup> Familial nonmedullary thyroid carcinoma<sup>25</sup> and a family history of thyroid cancer<sup>26</sup> also increase the risk, although family history is also entwined with the first risk factor, as family members of those who have been diagnosed through medical imaging are themselves more likely to request or be recommended for the same imaging.<sup>5,26,27</sup>

The increase in thyroid cancer rates in the nation and in the world is largely due to the overdiagnosis of tumors that only became apparent as advances in imaging technology made them detectable.<sup>5</sup> Overdiagnosis is when an asymptomatic person is diagnosed with a condition for which the diagnosis does not yield any benefit. A detailed review article published in 2018 explains how a number of contributing factors has led to a cycle of ever-increasing diagnosis.<sup>5</sup> Many of these are germane to conditions on Staten Island, as detailed in the following sections.

## ***Tumor Characteristics***

### **Occult cases**

The “true” rate of thyroid cancer is very high but remains mostly undiagnosed. Results from autopsy studies suggest that over 10% of the population has thyroid cancer at the time of death and that this figure has been stable since 1970.<sup>28</sup> The National Cancer Institute presently estimates that 1.2% of people will be diagnosed with thyroid cancer in their lifetime.<sup>29</sup> This means that diagnosis rates could increase another tenfold in the absence of any change in actual risk, simply through better detection. These additional undiagnosed cases are known as



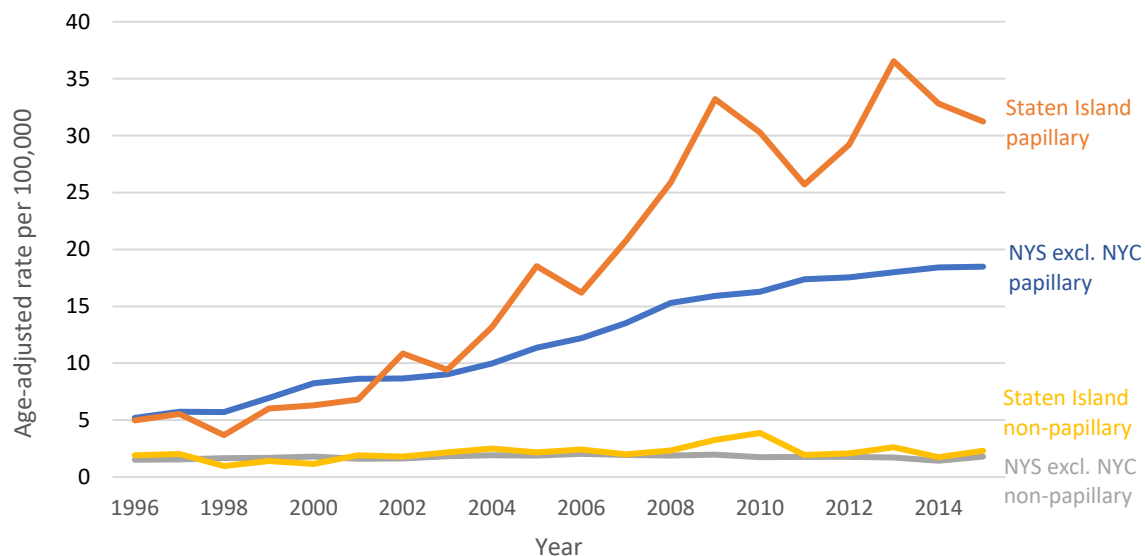
occult cases. Their presence suggests that the substantial majority of thyroid cancers pose no actual health risk and that no purpose is served by their early detection and treatment. Otherwise, we would expect to see increases in mortality, which has not been the case. The death rate from thyroid cancer in New York State has been steady at 5 per million since 1976.

## Cell type

Nearly all the increase in thyroid cancer has been of the papillary subtype. A useful way of evaluating thyroid cancer trends is to subdivide thyroid cancer into subtypes based on the histology, or how the cancer cells appear under a microscope. There are five broad subtypes of thyroid cancer: papillary, follicular, medullary, anaplastic, and other (see technical notes for precise definitions). Papillary carcinoma is the most common type, accounting for about 93% of the cases in New York State. This cancer tends to be very slow growing and is rarely fatal. Follicular carcinoma is the next most common type, comprising 4% of the total. It also tends to have a good prognosis but can be more aggressive than papillary. This subtype is the one most associated with dietary iodine deficiency. Medullary carcinoma accounts for 2% of the total and is even more aggressive. This tumor type is associated with elevated levels of the hormone calcitonin that are readily detectable by blood tests. Anaplastic carcinoma is the most aggressive tumor type of all and is frequently inoperable. Both anaplastic and the “other” category represent less than 1% of the total tumors.

Figure 3 shows the overall trends for papillary and non-papillary thyroid tumors on Staten Island and New York State excluding New York City. (The latter grouping was chosen for clarity, as the follicular, medullary, anaplastic and other categories each have such low rates they are difficult to distinguish on a graph). Papillary carcinoma is responsible for nearly all the increase, while the other histologies collectively had stable rates. Specifically, between 1996 and 2015,

**Figure 3. Thyroid cancer incidence by tumor type.**

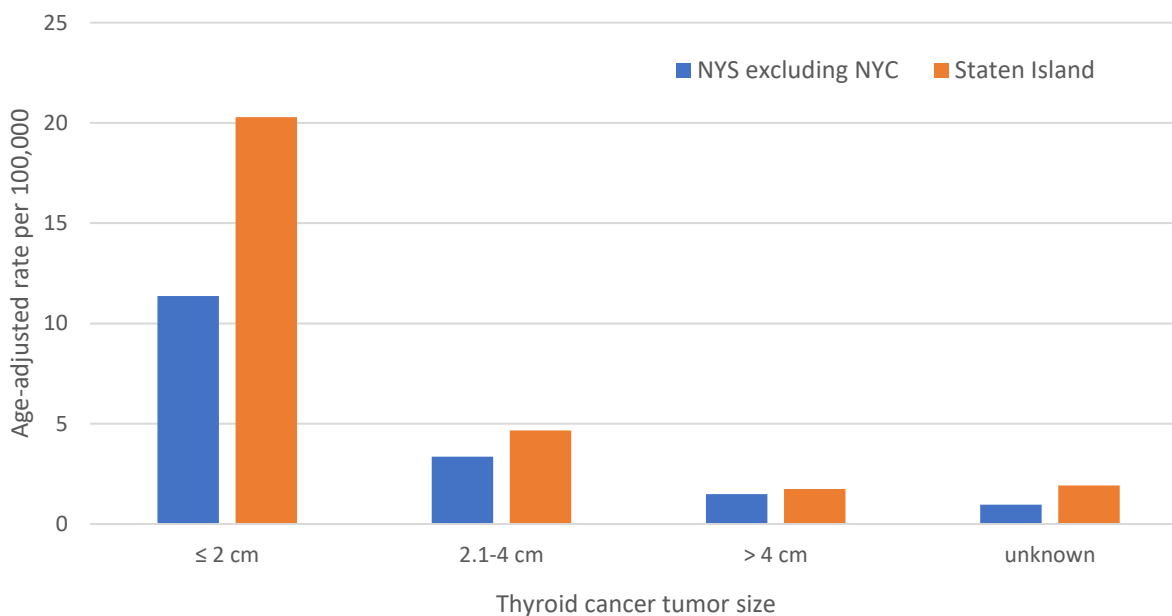


papillary carcinoma rates increased by a factor of 3.6 in New York State excluding New York City and by a factor of 6 on Staten Island. Non-papillary tumors increased about 20% in both locations. The percentage of all thyroid tumors that were of papillary type increased from 78% to 92% in New York State excluding New York City and from 77% to 92% on Staten Island. Each of these trends is consistent with unchanging mortality rates.

## Tumor size

Nearly all the increase in thyroid cancer has been for tumors small enough to be considered subclinical. In general, tumors of less than or equal to 2 centimeters in size are considered subclinical, meaning they are not characterized by readily observable symptoms. Figure 4 shows that 85% of the difference in rates between Staten Island and New York State excluding New York City is among tumors less than or equal to 2 centimeters. This is consistent with results from an influential paper by Davies and Welch,<sup>30</sup> who found that 87% of the increase in thyroid cancer in their study period was among small tumors. Moreover, some studies have found that physical examinations by health care providers are not especially effective at finding nodules even greater than 2 centimeters, so the switch to technology-driven diagnosis could explain even some of these larger tumors.<sup>31</sup>

**Figure 4. Thyroid cancer rates by tumor size, 2004-2015.**



## Behavioral Factors

### Tobacco use

Many types of cancer are known to be smoking-related, although thyroid cancer is not among them. Over three-quarters of deaths from lung and larynx cancer are attributable to cigarette

smoking along with roughly half of deaths from urinary bladder, esophagus, and oral cavity.<sup>32</sup> For all but laryngeal cancer, rates on Staten Island are below those of New York State excluding New York City (see Table 1). For laryngeal cancer, rates on Staten Island are 17 percent higher. Only for esophageal cancer (51% lower on Staten Island) are the rates considered statistically different between Staten Island and New York State excluding New York City.

According to the Behavioral Risk Factor Surveillance System (BRFSS) survey conducted by the New York State Department of Health in 2016, the age-adjusted current smoking rate on Staten Island was 12.8%. This was lower than Brooklyn (13.3%) and higher than the Bronx (11.4%), Queens (11.2%) and Manhattan (9.8%). It was also below the rate for nine of the ten regions outside of New York City for which the BRFSS reports data.<sup>33</sup> These include the North Country (24.2%), Mohawk Valley (24.0%), Southern Tier (24.0%), Tug Hill/Seaway (22.6%), Western New York (21.8%), Central New York (19.5%), Finger Lakes (19.0%), Capital Region (17.5%), and Long Island (13.8%). The only region below Staten Island was Mid-Hudson, at 11.7%. Given that the rates of both smoking and tobacco-related cancers on Staten Island are generally below those of New York State excluding New York City, there does not appear to be anything unusual or remarkable regarding this relationship on Staten Island.

## **Obesity**

Obesity is weakly associated with thyroid cancer, and probably explains little of the Staten Island excess. The International Agency on Research in Cancer (IARC) issued a comprehensive report in 2018 reviewing the science of the relationship between obesity and cancer.<sup>34,35</sup> Thyroid cancer was found to be weakly associated with body fatness, with the relative risk for obese persons about 10% higher than for overweight persons, and 20% higher than persons of normal weight. According to the 2016 BRFSS, 25.5% of the population of New York State, 22.9% of New York City and 21.7% percent of Staten Island was obese, while the percent overweight were 35.0% for New York State, 36.1% for New York City, and 38.7% for Staten Island.<sup>33</sup> The values for both the percent obese and overweight on Staten Island are statistically similar to those for New York State and New York City. Only a small proportion of thyroid cancer diagnoses are attributable to obesity – between 5% and 10%, depending on certain assumptions – and the proportion on Staten Island would be similar to that in the rest of the state. Other cancers that have been associated with obesity do not have rates that are higher on Staten Island than the rest of New York City and/or New York State.

## ***Healthcare Factors***

### **Diagnostic imaging**

The increase in thyroid cancer on Staten Island, New York, the US, and the world corresponds to an increase in routine diagnostic imaging. This relationship has been widely observed and analyzed across many studies. A 2014 Canadian study, for example, found that thyroid cancer incidence in subregions of Ontario varied by more than a factor of 4 and was highly correlated with the per capita rate of neck ultrasounds ordered in each region.<sup>36</sup> In addition, thyroid

cancer incidence was also highly correlated with other discretionary medical tests unrelated to thyroid cancer, including ultrasounds of other parts of the body and cardiograms. These tended to be in more urbanized and highly educated regions. Another study reported that within the Veteran's Affairs Health Care System between 2000 and 2012 thyroid cancer incidence doubled, ultrasound usage increased by nearly a factor of 5 and fine-needle aspiration of the thyroid increased by nearly a factor of 7.<sup>37</sup> Other studies have reported an almost perfect correlation between CT scan volume and papillary carcinoma of less than one centimeter.<sup>38,39</sup> In short, for many of these tumors, absent highly sensitive imaging technology that did not exist until recently, they would have never become clinically apparent.

Replicating these findings in New York proved difficult. We identified three sources of ultrasound data: the New York State hospitalization file, known as SPARCS; New York State Medicaid claims; and a 5% sample of New York State Medicare claims. We were specifically interested in Current Procedural Terminology code 76536 ("Ultrasound, soft tissues of head and neck (e.g. thyroid, parathyroid, parotid), real time with image documentation"). The SPARCS file showed wide year-to-year fluctuations that appeared more reflective of variation in reporting practices than to any true variation in the administration of neck ultrasounds. Medicaid data suggested a doubling of neck ultrasounds in New York State between 2006 and 2015, leveling off in 2016 and 2017, with Staten Island lagging somewhat behind the statewide numbers. These Medicaid data are accurate and reliable – they are the basis for how physicians are paid - but thyroid cancer overdiagnosis is much more characteristic of the privately insured population.<sup>40</sup> Medicare data tracked the cancer incidence trend most closely, with neck ultrasounds doubling statewide between 2004 and 2012 but tripling on Staten Island. Here again, though, the data were not necessarily reflective of the typical thyroid cancer patient, who has a median age of 47, while nearly all Medicare patients are aged 65 and older. The ideal data set for this investigation would make use of claims data from privately insured patients of working age, but no such data set is presently available.

In addition to more diagnostic imaging yielding greater detection of tumors, certain forms of diagnostic imaging are themselves risk factors for many types of cancer, because of the radiation exposure that accompanies such imaging. A recent meta-analysis found that past exposure to computed tomography (CT) scans, dental x-rays, and scans and x-rays specifically of the head, neck and chest were all associated with elevations in thyroid cancer ranging from 31 to 71%.<sup>15</sup> The authors acknowledged that it was not possible to distinguish the effects of the radiation from the incidental diagnoses from the tests themselves. However, they did argue that dental x-rays, which were accompanied by a 69% increase in thyroid cancer risk, would not be expected to result in any incidental thyroid cancer diagnoses.

## **Screening**

Some people residing on Staten Island have received free thyroid cancer screening at screening events. However, no public health agency endorses routine thyroid cancer screening, and active treatment for the earliest-detected thyroid cancers is not the standard of care. The United States Preventive Service Task Force gives thyroid cancer screening a D rating, meaning that

harms outweigh benefits.<sup>41,42</sup> The American Cancer Society and the National Cancer Institute similarly make no endorsements of thyroid cancer screening. It is understandable that the public, exposed to messages of “cancer awareness” and “early cancer detection saves lives”, often fails to distinguish between the few types of cancers for which screening is beneficial and the many for which it is not, or for which a screening test does not exist.

There has also been confusion between recommendations for tests for thyroid function and tests for thyroid cancer. For example, one public web site notes that risk factors for thyroid cancer include age, family history, surgery or radiation to the neck, type I diabetes and pregnancy, and that the American Thyroid Association (ATA) recommends that all adults 35 and over see their physician for a thyroid screen at least once every five years. However, type I diabetes and pregnancy are risk factors for abnormal thyroid function, not thyroid cancer, and the ATA recommendation applies to screening for abnormal thyroid function, not thyroid cancer.

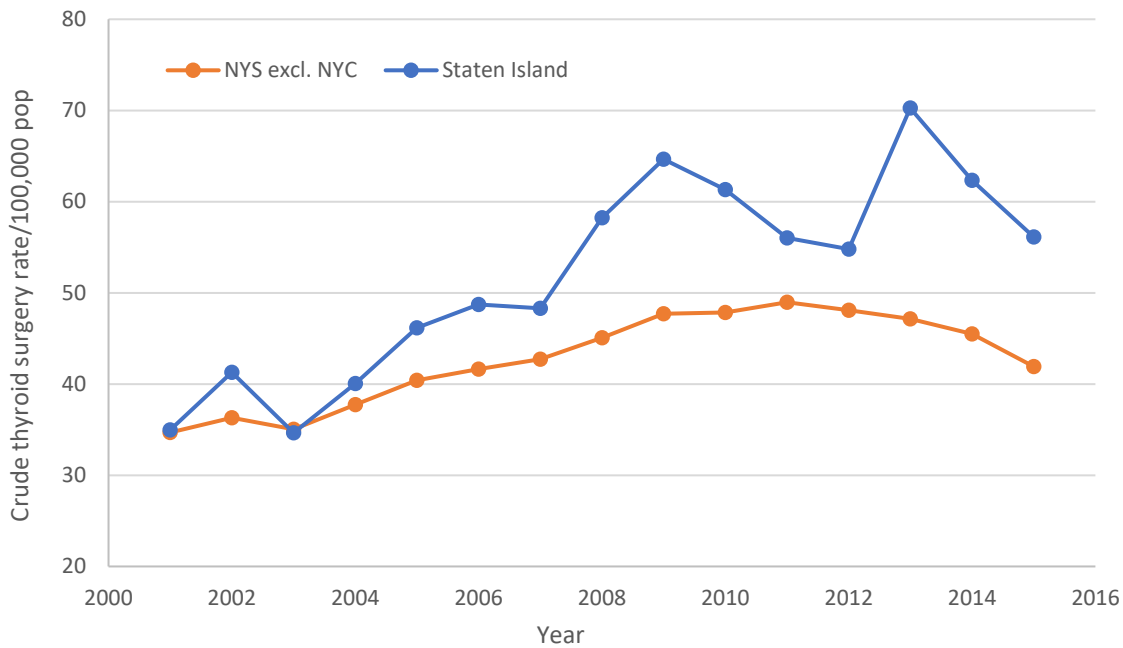
While promotion of thyroid cancer screening has been seen on Staten Island more than any other part of New York, it is not unique to Staten Island. We also found evidence of similar initiatives in Rockland and Westchester Counties. Notably, these two counties also have above-average thyroid cancer rates. Thus, these screening events end up serving as both a response to elevated cancer rates and a cause of still-higher rates. They are examples of the kind of positive feedback loop that ensues when heightened awareness and publicity around the thyroid cancer epidemic leads to more people seeking thyroid screening.

## **Surgery**

Thyroid surgery is performed more frequently on Staten Island than elsewhere. Since most thyroid cancer diagnoses are treated with surgery, it makes sense that an area with higher cancer incidence rates would have higher rates of surgery. However, with thyroid cancer, the sequence is often reversed: the thyroid gland is first removed surgically, and cancer is discovered after the removed tissue is evaluated by a pathologist. In this manner, many patients learn they have been surgically cured of thyroid cancer without having been aware they had cancer to begin with. Examples of benign conditions which can result in thyroid surgery are benign nodular thyroid disease, hyperthyroidism, Grave’s disease, and other forms of goiter. One study found that 26% of all thyroid cancers were found in this manner.<sup>43</sup>

The Cancer Registry data do not allow the ability to discern the surgery-diagnosis sequence, or whether the distribution of the sequence differs on Staten Island. Nevertheless, Figure 5 suggests that this is probably not an important driver of the elevated thyroid cancer rates on Staten Island. Thyroid cancer rates on Staten Island are nearly 70 percent higher than in New York excluding New York City, but thyroid surgery volume, as tabulated using SPARCS data, is only about 20 to 40 percent higher, depending on the year.

**Figure 5. Thyroid cancer surgery trends for Staten Island and NYS excluding NYC.**



### ***Occupational Factors***

The number of first responders, firefighters, and rescue and recovery workers involved in the response to the World Trade Center attacks who live on Staten Island has likely had a very small influence on thyroid cancer rates. Multiple studies of these groups have found two-to-threefold excesses of thyroid cancer and up to a 50% excess in prostate cancer through 2008.<sup>44</sup> The excess in thyroid cancer further persisted through 2011 for a group monitored by the New York City Department of Health and Mental Hygiene.<sup>45</sup> According to these reports, the higher incidence of these cancers in the period directly after the attacks is believed to be due to the enhanced medical surveillance that most of these people received. This is because the primary route of exposure for carcinogens from the World Trade Center attacks would have been through inhalation or skin contact, neither of which are associated with thyroid or prostate cancer. Moreover, thyroid and prostate cancer are among the cancers that are the most sensitive to screening intensity. In addition, the latency periods for each of these cancers are measured in decades, not years, so that exposures from the World Trade Center alone could not have resulted in these cancers developing in such a short time. These findings are evocative of the aftermath of the Fukushima nuclear disaster in Japan. Immediately after this event, thyroid cancer screening intensified dramatically in South Korea, resulting in rates increasing more than six-fold in a decade, to the highest levels in the world.<sup>46,47</sup>

Staten Island is the home of a disproportionate share of New York City’s firefighters, and so one hypothesis is that the firefighters themselves may be influencing the borough’s thyroid cancer rates. Exact figures are not publicly available, but data from the 2011-2015 American Community Survey suggest that the percentage of the workforce engaged in firefighting and closely related professions is 2.6% on Staten Island, versus 1.9% in New York City, though lower

than the 2.9% in the Bronx. A doubling or tripling of risk in this population would only have a very small influence on the overall 90% elevation seen among all men in Staten Island relative to the other four boroughs (Table 1b). Additionally, as nearly the entire firefighter cohort are men, this offers no explanation for the similar elevations in thyroid cancer among women on Staten Island. We note also that prostate cancer rates on Staten Island are below those of both the rest of New York City and New York State excluding New York City. Other cancers known to be associated with specific occupational exposures do not have rates that are higher than the rest of New York City and/or New York State.

## ***Other Factors***

### **Disease Reclassification**

Some thyroid cancers have recently been reclassified as non-cancers. Beginning with cases diagnosed in 2017, cases diagnosed with encapsulated follicular variant papillary thyroid carcinoma (eFVPTC) without capsular or vascular invasion were reclassified as noninvasive follicular thyroid neoplasm with papillary-like nuclear features (NIFTP). The decision to reclassify the histopathologic nomenclature was based on the excellent prognosis of this very low-risk tumor variant, as it has a very low potential for recurrence after surgery alone. It is important to note that the name change removes the word ‘carcinoma’ from the diagnosis and uses the word ‘neoplasm’, in effect making this a non-cancer diagnosis.<sup>48</sup> Prior to 2017, eFVPTC without capsular or vascular invasion was classified as malignant. Under the new classification term of NIFTP, these cases are being reported with a behavior of 2 (in situ) and will not be included in future totals of malignant thyroid cancer cases.<sup>49</sup> Because of this change, we expect to see a decrease in the rate of thyroid cancer cases, as in situ cases are not included in the NYSCR published cancer rates. The exact impact this change in histopathologic nomenclature will have on the rates of thyroid cancer in NYS and the United States remains to be seen, but preliminary estimates suggest it will be in the range of a 2 to 5% decrease.<sup>50,51</sup>

### **Physician Behaviors**

Some studies have found that certain physicians are much more likely to diagnose thyroid cancer than others when presented with the same evidence.<sup>52,53</sup> This may stem in part from the pressure some physicians feel to “round up” ambiguous findings to the level of cancer, fearing lawsuits.<sup>54,55</sup> It is possible that such doctors are overrepresented on Staten Island, though we had no way of measuring this as this information is not captured by public health surveillance data.

### **Immigration**

Immigration from Russia, Belarus and Ukraine does not appear to have influenced thyroid cancer rates on Staten Island. We considered whether migration to Staten Island from Russia, Belarus and Ukraine since the 1980s could have influenced the rates given the possible exposure of these people to the Chernobyl nuclear accident. The Cancer Registry records

patients' country of birth but not their time of immigration, making it impossible to ascertain which immigrants may have had this exposure. Nevertheless, the total emigration to Staten Island from these countries is exceeded by the amount of migration to Brooklyn (both in absolute numbers and as a proportion of the population), and thyroid cancer rates in Brooklyn are 33% lower than on Staten Island. According to the 2011-2015 American Community Survey, Brooklyn had 96,678 immigrants from these three countries out of 2,595,259 total residents (3.7%), while Staten Island had 11,990 out of 472,481 (2.5%). These figures suggest that immigration from these three countries is not an important contributory factor.

## ***Environmental Factors***

### **Outdoor Air Quality**

The criteria air pollutants database provides the longest history of air pollution measurements in New York. Long-term trends for criteria pollutants (carbon monoxide, nitrogen dioxide, particulate matter, and sulfur dioxide) can be found in Appendix B, Figures B1-B3. Criteria air pollutant concentrations have decreased substantially over time, and in terms of meeting the USEPA National Ambient Air Quality Standards (NAAQS) for the criteria pollutants, this study area currently complies with the NAAQS for all pollutants except ozone. The primary NAAQS are health-based, however, the levels are not specifically based on the risk of developing cancer. Information about ozone has not been presented in this report for a number of reasons. It is not a carcinogen and it is not released from sources. It is formed from the release of volatile organic compounds (VOCs) in the presence of sunlight. Therefore, concentrations are measured much farther downwind from the source releasing VOCs. More information on criteria pollutants can be found on-line: <https://www.epa.gov/criteria-air-pollutants>.

The International Agency for Research on Cancer (IARC) has classified particulate matter in outdoor air pollution as a group 1 carcinogen for lung cancer, meaning that sufficient causal evidence exists. However, lung cancer on Staten Island is 3.7% below the rate for New York State excluding New York City and is not a focus of this report. Sulfur dioxide is classified by the International Agency for Research on Cancer (IARC) as a group 3 carcinogen, meaning there is insufficient evidence to determine its carcinogenicity to humans. Neither carbon monoxide nor nitrogen dioxide are classified by IARC. None of these pollutants have been linked to thyroid cancer.

The air toxics data base is fairly recent. The statewide network was established in 1990. However, there is information about the ambient concentrations of specific air toxics of concern on Staten Island since 1988. Trends calculated using all available data for select air toxics data know to be "risk-drivers" because measured levels are above DEC's Annual Guideline Concentration (AGC) can be found in Appendix C, Figures C1-C5, along with a brief summary of toxicological and contextual information. All air toxics presented, with the exception of carbon tetrachloride, are predominantly from mobile sources. Although the concentrations for these five air toxics are higher than DEC's AGC, measurements at most locations in the state for these air toxics are higher than the AGC. Except for carbon



tetrachloride, many of the air toxics of concern are directly released from mobile sources or formed from VOCs released from mobile sources. The historical concentrations and trends from 1990 to 2017 on Staten Island follow the same pattern as other locations in the state. Because there are no air toxics monitoring data for other locations in the state, a definitive statement about exposures prior to 1990 cannot be made. At least for the time period of 1990 to current, exposures to the five air toxic concentrations would not be considered unique to Staten Island. Of the five air toxics described in Appendix C, three (benzene, 1,3 butadiene and formaldehyde) have been linked to hematopoietic cancers to varying degrees. These cancers include leukemia, lymphoma, and multiple myeloma. Benzene has also been associated with lung cancer, and formaldehyde with nasal cavity and nasopharynx cancer. The cancer rates on Staten Island for each of these cancers are similar to or below those of New York State excluding New York City. None of these chemicals has been associated with thyroid cancer.

DOH researchers also used the NATA modeled inhalation risk estimates for 2011 and 2014 emission inventory years to evaluate whether cancer risk, based on exposures to EPA-designated hazardous air pollutants (HAPs), in the study area was unusual as compared to other comparison areas of New York State. The comparison areas used were the average risk estimates for New York State and New York State exclusive of New York City. For Staten Island, a third comparison area was used comprising New York City excluding Staten Island. An increase in exposure to either a trace amount of an air pollutant or a pollutant with very low carcinogenic risk is unlikely to elicit an increase in adverse health effects that can be detected epidemiologically. Therefore, all HAPs were initially screened for each study area to determine which pollutants were estimated to have more than the mathematical probability of one excess cancer (all cancers combined) in a population of one-million (or a one-in-one-million cancer risk). This resulted in a selection of a subset of five pollutants. Next, a ratio comparing the cancer risk estimate for the study area to the cancer risk estimate for each comparison area was calculated for each of the five HAPs. A ratio greater than one indicates the estimated cancer risk was higher in the study area than in the comparison area.

Table 2 and Table 3 show the comparison ratios and risk estimates for the five pollutants included in the evaluation for NATA 2011 and 2014. The tables show that Staten Island has lower or similar risks than the rest of New York City, higher or similar risks than New York State excluding New York City, and similar risks to New York State for each of the chemicals.

**Table 2. NATA 2011 Comparison Ratios and Risk Estimates for Staten Island**

	Ratio showing Staten Island compared to:			Total Cancer Risk (per million)			
	Other 4 Boroughs	NYS excl. NYC	NYS	Staten Island	Other 4 Boroughs	NYS excl. NYC	NYS
1,3-Butadiene	0.64	1.85	1.03	3.61	5.65	1.96	3.51
Acetaldehyde	0.80	1.31	1.03	4.34	5.42	3.31	4.20
Benzene	0.68	1.42	0.97	8.23	12.12	5.81	8.47
Carbon Tetrachloride	1.00	1.00	1.00	3.28	3.28	3.28	3.28
Formaldehyde	0.81	1.47	1.10	22.49	27.70	15.26	20.51

**Table 3. NATA 2014 Comparison Ratios and Risk Estimates for Staten Island**

	Ratio showing Staten Island compared to:			Total Cancer Risk (per million)			
	Other 4 Boroughs	NYS excl. NYC	NYS	Staten Island	Other 4 Boroughs	NYS excl. NYC	NYS
1,3-Butadiene	0.58	1.87	0.97	1.78	3.07	0.95	1.85
Acetaldehyde	0.85	1.27	1.05	2.22	2.60	1.75	2.11
Benzene	0.70	1.37	0.98	4.83	6.92	3.52	4.96
Carbon Tetrachloride	1.00	1.01	1.00	3.30	3.30	3.28	3.29
Formaldehyde	0.85	1.35	1.08	16.81	19.74	12.49	15.55

Since modeled data require assumptions that can add error to results, DEC researchers evaluated the accuracy of both the NATA model years by comparing the modeled concentrations to monitored concentrations measured in DEC’s air toxics monitoring network. This analysis demonstrates that the modeled results can be used with confidence to estimate historical exposures. These results are shown in Appendix D.

### Radon in Indoor Air

Radon is a naturally occurring radioactive gas that has no color, odor or taste and is formed during decay of uranium in soil, rock and water. It can get into indoor air from soil under homes and other buildings through cracks, openings and various penetrations in the building foundation. Rarely, radon can be found dissolved in ground water and enter indoor air through use of well water in washing machines, showers etc. Radon concentration in a home is dependent on many factors including type of soil under the home, and ventilation rate and air flow patterns within a house. For example, radon levels can be higher in homes that are well insulated, tightly sealed, and/or built on soil rich in the elements uranium, thorium, and radium. Due to their closeness to the ground, basement and first floors typically have the highest radon levels in the building.

Radon in homes is the largest source of radiation exposure to the general public. Most inhaled radon is rapidly exhaled, but the decay products can deposit in the lung. These radioactive particles can cause damage to cells lining the airways, increasing the risk of lung cancer. We are unaware of any studies that have found an association between radon and thyroid cancer. Staten Island is not part of an area with unusual levels of naturally occurring radon.

The Radon Program at the DOH Bureau of Environmental Radiation Protection has tracked voluntary home radon testing results since 1987 (<https://www.health.data.ny.gov/Health/Radon-Test-Results-By-County-Beginning-1987/8e6u-9695>). Data from 1987 to 2015 are presented in Table 4. Based on these results, it does not appear that radon is a significant environmental exposure on Staten Island. Moreover, lung cancer rates on Staten Island are 4% below those for NYS excluding NYC (Table 1a).

**Table 4. Home radon test results in New York State, 1987-2015**

	Number of tests	Average reading, basement tests	Average reading, first-floor tests	% of tests above action level
Staten Island	374	1.55	1.33	7.50
New York City	2,269	1.69	1.38	6.74
NYS excl. NYC	129,645	7.06	3.85	34.30
New York State	131,914	6.96	3.81	33.83

## Drinking Water Quality

Staten Island is served entirely by the New York City Water Supply. New York City’s drinking water is sourced from an interconnected surface water supply system, which comprises three controlled lakes and 19 reservoirs, encompassing a nearly 2,000-square-mile watershed from which water is drawn. The Croton system is in Dutchess, Putnam, and Westchester Counties. The Catskill/Delaware surface sources are in Delaware, Greene, Schoharie, Sullivan, and Ulster Counties. In the past, some groundwater wells located in Queens were also used and delivered water to fewer than 100,000 customers, but have not operated since 2007.

The Catskill/Delaware sources supply 91% of New York City’s water and all of Staten Island’s water. It is regarded as being one of the highest quality surface drinking water sources in the country. As such, this water does not require filtration as a form of treatment. Instead, the supply is operated under a Filtration Avoidance Determination (FAD), which incorporates other treatment protocols. Since 1993, New York City has met the requirements of the 1989 Surface Water Treatment Rule (SWTR) and, after 1998, the Interim Enhanced Surface Water Treatment Rule (IESWTR). This allows the city to avoid filtering the Catskill/Delaware water supply. Rather, water is first treated through the introduction of chlorine. Following this, water is sent to Ultra-Violet (UV) Disinfection Facilities in Westchester County, where UV light inactivates any remaining and potentially harmful biological contaminants. Fluoride is added to the water at a federally approved concentration to improve dental health for NYC residents. Sodium Hydroxide is also added, raising the pH level of the water, reducing the corrosion of household plumbing. Finally, food grade phosphoric acid is added, creating a protective film on pipes, thus reducing the release of metals like lead from service lines and household plumbing. Drinking water is then circulated to the New York City distribution areas. New York City is one of only five major cities in the entire country able to operate under a Filtration Avoidance Determination due to the Catskill/Delaware watersheds’ pure water supply.

Monitoring of drinking water quality and testing for contaminants follows DOH and federal government requirements. A complete list of analytes tested is provided in Appendix A, Table A1. An analysis of sample data for the New York City System for 1997 through July 2018 revealed no MCL violations. The data confirm the claim made by the New York City Department of Environmental Protection’s 2017 Drinking Water Supply and Quality Report: water sourced

from the Catskill/Delaware watersheds and provided to Staten Island is among the highest quality in the country.<sup>53</sup>

USEPA's Unregulated Contaminant Monitoring Rule (UCMR) collects occurrence data for contaminants that do not have health-based standards set under the Safe Drinking Water Act but may be present in drinking water. The monitoring consists of no more than 30 contaminants every five years and is collected from all large public water systems (> 10,000 people) and a representative sample of small public water systems. The data collected helps to inform future regulatory determinations.

USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR 3) occurred between 2013 and 2015. The list of UCMR 3 contaminants can be found in Appendix A, Table A2. The UCMR 3 contaminants detected in Staten Island public water systems were all below USEPA reference levels provided in EPA's UCMR 3: Data Summary, January 2017.<sup>54</sup> EPA's reference concentrations provide context but do not represent an "action level". They are health guidelines estimated from animal studies with a level of uncertainty built in.

## **Industrial and Inactive Hazardous Waste Disposal Sites**

One of the primary concerns among Staten Island residents for many decades has been exposure from the former Fresh Kills landfill on the western side of the island. The Fresh Kills landfill was active between 1948 and 2001, and for most of this period was regarded as having been the largest landfill in the world. At the peak of its operation in the mid-1980s, it received 29,000 tons of waste per day. From 1991 until 2001 it was the sole site for all of New York City's waste. Today, waste from New York City is transported to other states including Pennsylvania, Ohio, and South Carolina.

The landfill was briefly reopened following the 9/11 attacks and used as a sorting area to identify human remains and personal effects. Some of the debris generated by the attacks was also buried here. Presently, the site is in the midst of a thirty-year plan to be redeveloped as Freshkills Park.<sup>55</sup> The park will be New York City's largest, more than three times the size of Central Park.

Adverse health effects from the landfill have long been a concern to Staten Islanders. A comprehensive report issued by the ATSDR (Agency for Toxic Substances and Disease Registry) in 2000, summarizing 8 years of research and analysis, found that while chemical hazards were present, they presented little to no public health hazard.<sup>56</sup> Specifically, the report noted that exposure to groundwater, surface water, or in fish or shellfish was unlikely given advisories and restrictions on site access. All of Staten Island is served by the public water supply. Exposure to contaminated air was likely, but no measurements during the 1990s ever exceeded levels designated as "unsafe" or "unhealthy". The report was not able to assess air emissions prior to 1990 given the lack of data.

A report from the New York City Department of Health and Mental Hygiene in the same year focused exclusively on cancer in proximity to Fresh Kills between 1978 and 1992.<sup>57</sup> It concluded “these analyses do not indicate consistent evidence of elevated cancer rates specific to the landfill area. For the majority of cancer sites, rates in the study area were lower than, or equivalent to, rates in the rest of Staten Island. The moderate elevations noted for leukemia among children and central nervous system cancers among men and women during this time period were of an opposite pattern from those noted during the previous study period, so they could represent natural variation in rates over time”.

It continued, “These additional analyses also indicate that cancer incidence for most cancers on Staten Island as a whole was not significantly different than elsewhere in the city. Also, trends in cancer incidence on Staten Island are not significantly different from those elsewhere in the city for most sites. Importantly, children on Staten Island had significantly lower rates of cancer than children in the rest of the city. However, for the time period evaluated in these analyses there continue to be statistically significant elevations for some adult cancer types on Staten Island and several of these cancers also have trends that are statistically significantly different from the comparison areas for the 15-year time period evaluated”.

The scientific literature related to Fresh Kills since 2001 has only related to concerns over respiratory conditions such as asthma and post-traumatic stress disorder among those who worked at Fresh Kills after it was temporarily re-opened following the 9/11 attacks. No studies related to cancer have been undertaken. In 2018, the New York City Department of Health and Mental Hygiene undertook an analysis of cancer rates with respect to proximity to Fresh Kills. This report has not yet been released at the time of this writing.

Based on a review of available data, there is no information suggesting that contamination from any other existing and known remedial sites is causing widespread exposures on Staten Island. In some cases, on-site contamination exists but is not causing off-site exposure. For other sites, information continues to be gathered. For many sites, actions to identify, control, and/or remove existing contamination have been implemented and completed. More information about the status of each site can be found in Appendix E. For additional information about any of these sites listed below, please contact DOH staff at (518) 402-7860 or visit the DEC environmental site remediation database website at <https://www.dec.ny.gov/cfmx/extapps/derexternal/index.cfm?pageid=3> and enter the site code provided in Appendix E.

## **Traffic**

The most heavily trafficked roads are Interstate 278, which run east-west through the northern part of Staten Island, and Route 440, which runs through the western part of Staten Island. Staff looked at the proportion of people who live within 500 meters of roads with traffic density information. On Staten Island, 11% of people live within 500 meters of roads with an annual average daily traffic (AADT) volume of 75,000-300,000 vehicles, 28% within 500 meters of roads with an AADT volume of 25,000-74,999 vehicles, and 61% live near roads with less AADT. New

York City, being an urban area with substantial traffic, provides the closest comparison. Compared to New York City, Staten Island has a lower percentage of people that live within 500 meters of roads with an AADT volume of 75,000-300,000 vehicles, and a slightly lower proportion of people living within 500 meters of roads with an AADT volume of 25,000-74,999 vehicles, while the remaining people live near roads with less AADT. As expected, Staten Island has a higher proportion of people who live close to the most heavily trafficked roads in comparison to NYS excluding NYC, which includes rural areas with low traffic density. NATA also incorporates mobile sources (*i.e.*, traffic) in its modeled estimates of air toxics. Therefore, the contribution of traffic is also accounted for in those results. Broadly speaking, the NATA results are consistent with these traffic density results (see Table 4). Finally, we are not aware of any studies linking thyroid cancer with vehicular traffic.

**Table 4. Population living within 500 meters (m) of DOT monitored roads**

<b>Geographic Area</b>	<b>% population within 500 m of road with 75,000-300,000 AADT</b>	<b>% population within 500 m of road with 25,000-74,999 AADT</b>	<b>% population within 500 m of road with &lt;25,000 AADT</b>
Staten Island	11%	28%	61%
NYS excluding NYC	5%	14%	81%
NYC	29%	30%	41%
NYS	15%	21%	64%

## **Limitations**

### ***General Considerations***

When attempting to draw conclusions from the data presented, there are certain considerations that should be kept in mind. One important issue is migration, that is, movement of people into or out of the study area. Cancer cases were identified among persons who resided in the study area when their cancers were diagnosed. Former residents of the study area who moved away prior to being diagnosed with cancer could not be included, while persons who developed cancer shortly after moving into the area were included.

This issue is particularly important in view of the long latency period of many cancers. Cancer latency refers to the time between first exposure to a cancer-causing agent and the appearance of cancer symptoms. For many cancers in adults, latency can be 10 years or more. This long latency gives people ample time to relocate in the time between exposure and the diagnosis of cancer.

### ***Limitations of Data Sources***

It is important to understand the strengths and limitations of each source of data used in the investigation.

### **Cancer Registry**

The cancer-related analyses in this study were based on data contained in the New York State Cancer Registry. The completeness and accuracy of the Cancer Registry depend upon reporting from hospitals, laboratories, other healthcare facilities, physicians and other sources. The Cancer Registry has been certified as more than 95 percent complete by the North American Association of Central Cancer Registries. In addition, the Cancer Registry has received gold certification from the Association since 2000 (data year 1996), the highest certification given to central cancer registries (1). Nonetheless, variation in cancer incidence between geographic areas reflects not only true differences in cancer incidence, but also differences in how cancer is diagnosed, treated, and recorded in different areas of the state.

### **Behavioral, Lifestyle, Medical Care Utilization**

Information on smoking prevalence and obesity was obtained from population-based surveys conducted by the New York State and New York City health departments, respectively. While these surveys are carefully designed to be representative of the population, as telephone-based surveys they have low response rates. Smoking rates were based on current smokers, while former smokers are also at increased risk for many cancers. In addition, the accuracy of the data depends on the accuracy of people's answers to the survey questions, which may vary based on the timing, wording and sensitivity of the questions. For example, the New York State survey found a current smoking rate on Staten Island of 13%, while the New York City survey found it to be 20%. There is no reason to believe, however, that any biases would operate any

differently on Staten Island than elsewhere.

Hospital inpatient and outpatient discharge data from the Statewide Planning and Research Cooperative System (SPARCS) were used as indicators of imaging and surgery volume. While SPARCS captures a large share of such encounters, it misses treatment obtained out of state, at Veteran's Administration-owned hospitals, and at physician's offices and other outpatient settings that failed to report their data. We also considered Medicare and Medicaid claims data as sources of thyroid-related data, but both sources fail to capture a substantial proportion of the at-risk population, which tend to be privately-insured individuals too young to be eligible for Medicare.

## **Occupational Factors**

Data on occupations were obtained from the American Community Survey of the US Census. This is another sample survey with a wide margin of error in small areas, so small differences between areas may not be meaningful. Data on occupation is generally tabulated into broad categories, and a large concentration of people in a specific occupation within a broad category might not be apparent.

## **Environmental Data Sources**

There are several limitations associated with examining environmental factors and their relationship to cancer development. First, the availability of environmental data is limited across space and time. For example, prior to the Clean Air and Water Acts of the 1970s, identification and control of sources of pollution released into the environment was not systematically enforced or recorded. Similarly, environmental monitoring networks do not provide information for all areas of NYS. Even now, data are not always readily available in digital or geographical formats.

Second, many of the environmental data sets that are available, such as regulatory compliance and monitoring data, have not been developed specifically to evaluate human exposures to chemicals in the environment. The amount and length of an individual's exposure as well as the likelihood of an environmental hazard to cause cancer are critical considerations in assessing the significance of environmental risk factors. Therefore, although this review could potentially identify questions that warrant further investigation, it could not quantify individual exposures to an environmental hazard.

Third, although environmental data have become more available over time, past exposures (as much as 40 years in the past) are generally more important for a full understanding of an individual's cancer risk. Available data do not include historical information about individual behaviors and specific exposures related to occupations and other activities.

Additionally, people are usually exposed to mixtures of chemicals rather than to a single chemical. Evaluating the health risks of mixtures is difficult for several reasons, including the



lack of information on chemical mixtures' effects on human health. This evaluation did not consider any modifications to a chemical's potency for any additive, antagonistic, or synergistic effects. Despite these challenges, DOH and DEC collaborated to summarize the readily available current and historical environmental data for each study region in order to make appropriate comparisons with the remainder of NYS.

## Conclusions

Cancer rates on Staten Island are modestly higher than those for the rest of New York City (16%) and slightly higher than those for New York State excluding New York City (3%). The difference between Staten Island and the rest of New York City is explained by the substantially lower cancer rates seen among Asians, Hispanics, and foreign-born persons of all races and ethnicities, all of whom are found in larger concentrations in the other boroughs of New York City.

Staten Island has unusually high rates of a single type of cancer, cancer of the thyroid, which occurs 67% more often than the rest of New York City and 69% more often than New York State excluding New York City. Staten Island averages 169 thyroid cancer cases per year; if it was similar to the rest of New York State only 100 would be expected. Put another way, thyroid cancer represents about 6% of the total cancers diagnosed on Staten Island but less than 4% of the total in the rest of the state.

Thyroid cancer has risen dramatically in New York – indeed, in nearly the entire world – in the past few decades. Staten Island has mirrored this trend, except between 2003 and 2008 when rates rose much faster than elsewhere in New York State. There is a strong scientific consensus that the recent increases in thyroid cancer are being driven by improvements in medical imaging technology that have made it easy to diagnosis small asymptomatic tumors, the natural prevalence of which in the population is quite high.

In our review of thyroid cancer on Staten Island, the stable mortality rates, small tumor sizes, cell type distribution, increases in diagnostic imaging, and aggressive local promotion of screening all support the consensus that increases in thyroid cancer are due to healthcare utilization factors. We did not find evidence that behavioral factors, such as tobacco use or obesity, were major contributors. We identified no environmental sources of thyroid cancer risk, and while screening has resulted in an excess of thyroid cancer among World Trade Center first responders, their numbers as a share of the total population are too small to influence the rates.

While thyroid cancer is rarely fatal, it is typically treated by the removal of part or all of the thyroid gland, which carries the risk of complications including permanent voice change, damage to adjacent parathyroid glands, hematoma, excessive bleeding, and sepsis. Given the long-term prognosis of thyroid cancer, some of these surgeries may be unnecessary. One solution to this problem is to encourage active surveillance of small, low-risk papillary thyroid cancers rather than defaulting to immediate surgery, as has been done successfully with prostate cancer, another slow-growing and rarely fatal cancer. However, there may be an upper limit to the number of patients willing to endure many years of active surveillance as opposed to curative treatment in the short term. For this reason, Sloan-Kettering endocrinologist R. Michael Tuttle endorses tackling the problem further upstream, by “stopping the diagnosis”.<sup>58</sup> This means decreasing screening and decreasing biopsies, so that asymptomatic, slow-growing cancers are never identified in the first place.

Public health agencies and medical organizations have long endorsed screening as a way to detect certain cancers earlier and save lives. Sometimes, lost in these messages is the fact that there are relatively few cancers for which screening provides a benefit. At present, the United States Preventive Services Task Force only endorses screening for two cancers with a grade of A (colorectal and cervical) and two with a grade of B (breast and lung for long-term smokers). (<https://www.uspreventiveservicestaskforce.org/Page/Name/uspstf-a-and-b-recommendations/>). An A grade means there is a high certainty of a substantial benefit; a B grade means there is a high certainty of a moderate benefit or a moderate certainty of a substantial benefit. For more than 100 other types of cancer, screening tests either currently do not exist, are believed to offer little to no benefit, or the harms outweigh the benefits.

## Recommendations

The recommendations below are divided into two sections: 1) recommended actions to address the specific cancer, thyroid cancer, that was elevated in the Staten Island Study Area, and 2) recommended actions to address all cancer types throughout New York State. Many of these specific recommended activities are aligned with two existing State plans that address cancer prevention and control, the New York State 2018-2023 Comprehensive Cancer Control Plan, and the New York State Prevention Agenda 2019-2024. Details about these two plans are described at the end.

### ***Recommended Actions Based on Specific Cancers Elevated in the Staten Island Study Area***

**Thyroid Cancer Screening:** The U.S. Preventive Services Task Force recommends against screening for thyroid cancer in asymptomatic adults. The USPSTF gives thyroid screening a “D” grade, meaning “there is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.” The USPSTF suggests that health care providers discourage the use of services with a D grade.

Recommendation: Educate the public and healthcare providers about recommendations against thyroid cancer screening in average risk, asymptomatic adults.

**Radiation from Medical Imaging:** Medical imaging tests, such as X-rays, computed tomography (CT) scans, and fluoroscopy, are non-invasive tests that health care providers use to diagnose diseases and injuries. Some of these tests use ionizing radiation which can lead to a small increase in the risk of cancer later in life.

Recommendation: Increase awareness of such programs as NYS’s “Image Gently” and the national “Image Wisely” campaigns that educate physicians and the public about potential radiation exposure from CT scans and X-rays in both children and adults.

### ***Recommended Actions to Reduce the Burden of All Cancers Statewide***

Preventing and controlling cancer requires individuals and organizations of all kinds to get involved and make contributions. Below are highlights of what individuals can do and what DOH and its partner organizations are doing. For more information on activities, by type of organization, that New Yorkers can do to help reduce the burden of cancer, see:

[https://www.health.ny.gov/diseases/cancer/consortium/docs/2018-2023\\_comp\\_cancer\\_control\\_plan.pdf#page=62](https://www.health.ny.gov/diseases/cancer/consortium/docs/2018-2023_comp_cancer_control_plan.pdf#page=62).

#### **For All New Yorkers:**

Different cancers have different causes and there are many factors that affect a person's chances of getting different types of cancer. It is not always possible to know why one person develops cancer while another person does not. But the following are things that all individuals can do to reduce their risk of cancer:

- If you use tobacco, quit. If you don't use tobacco, don't start.
- Eat nutritious meals that include fruits, vegetables and whole grains.
- Get moving for at least 30 minutes a day on five or more days each week.
- Use sunscreen, monitor sun exposure and avoid tanning salons.
- Limit alcohol use.
- Get cancer-preventive vaccines such as hepatitis B and HPV.
- Learn your family health history (if possible) and discuss with your healthcare provider whether genetic counseling might be right for you.
- Discuss what cancer screening tests might be right for you with your healthcare provider.
- Test your home for radon.
- For women of child-bearing age, know the benefits of breastfeeding and, if possible, breast-feed infants exclusively for at least the first six months of life.

**For NYS Department of Health and Partner Organizations:**

**Cancer Surveillance:** The New York State Cancer Registry (NYSCR) was designated by the CDC (Centers for Disease Control and Prevention) as a Registry of Excellence and has achieved Gold-level certification since 1998. In 2018, the NYSCR became a member of the National Cancer Institute's Surveillance, Epidemiology and End Results Program (SEER), the nation's preeminent source of population-based cancer data.

Recommendation: Continue to meet the highest cancer registry standards for timeliness, completeness and quality of data, and make these data available to researchers, clinicians, public health officials, legislators, policymakers, community groups and the public.

**Environmental Health:** DOH's Center for Environmental Health (CEH) programs work collaboratively with other agencies, including the NYS Department of Environmental Conservation, the federal Environmental Protection Agency, the Centers for Disease Control and Prevention (CDC), and the Agency for Toxic Substance and Disease Registry (ATSDR). CEH staff investigate the potential for human exposures from chemicals, radiation, microbes, or anything in the physical world at home, school, work or play that might affect health. CEH programs evaluate health effects associated with environmental exposures, develop policies, and maintain a variety of programs to reduce and eliminate exposures.

Recommendation: Continue to identify and assess potential exposures throughout the state and take action to reduce those exposures. NYS will continue to support programs to promote and maintain clean air, clean water and reduce human exposures to environmental hazards, with particular attention to the needs of environmental justice communities.

Recommendation: Promote awareness of programs and initiatives to reduce environmental hazards in our communities. Several state agencies promote programs and publish educational materials to reduce environmental exposures and improve health in our communities:

- DEC, Office of Environmental Justice:  
<http://www.dec.ny.gov/public/333.html>

- DOH, Health and Safety in the Home, Workplace and Outdoors: <https://www.health.ny.gov/environmental/>
- DOH, Healthy Neighborhoods Program: [https://www.health.ny.gov/environmental/indoors/healthy\\_neighborhoods/](https://www.health.ny.gov/environmental/indoors/healthy_neighborhoods/)
- DOH, Reducing Environmental Exposures: The Seven Best Kid-Friendly Practices: <https://www.health.ny.gov/publications/2818/>
- DEC, Green Living: <http://www.dec.ny.gov/public/337.html>
- NYSERDA's change-out incentive program for high-efficiency, low-emission wood heating systems: <https://www.nyserda.ny.gov/All-Programs/Programs/Renewable-Heat-NY>
- DOH, Protect and test your private drinking water wells: <https://www.health.ny.gov/publications/6628.pdf>

**Statewide Initiatives:** The overarching goal of cancer prevention and control efforts in New York State (NYS) is to reduce the burden of cancer by decreasing the number of new cancer cases, decreasing the number of cancers diagnosed at late stages, improving the quality of life of those diagnosed with cancer, and decreasing the number of deaths caused by cancer. These efforts are detailed in two State plans, the *New York State 2018-2023 Comprehensive Cancer Control Plan*, and the *New York State Prevention Agenda 2019-2024*.

- ***New York State 2018-2023 Comprehensive Cancer Control Plan (NYS CCCP)***

The *NYS 2018-2023 Comprehensive Cancer Control Plan* (Plan) was developed by the NYS Cancer Consortium and serves as a guide for community members, policy makers, advocates, healthcare professionals and others to use as they engage in efforts in their local communities and across the state. The NYS Cancer Consortium is a network of the Department of Health and over 200 individuals and organization in NYS that collaborate to address the burden of cancer in NYS.

The 2018-2023 Plan is organized around seven priority areas: 1) Cancer-Related Health Equity; 2) Health Promotion and Cancer Prevention; 3) Early Detection; 4) Treatment; 5) Survivorship; 6) Palliative Care; and 7) Health Care Workforce. Each priority area contains background information about the status of work in the area; objectives with which to measure improvements; suggested evidence-based or promising practices to make improvements; and other related resources. More details about the NYS Cancer Consortium and the Plan can be found at: <https://www.health.ny.gov/diseases/cancer/consortium/index.htm>

- ***New York State Prevention Agenda 2019-2024 (NYS PA)***

The *NYS Prevention Agenda 2019-2024* (Prevention Agenda) is New York's five-year state health improvement plan; it is the blueprint for state and local action to improve the health of New Yorkers and to reduce health disparities. The Prevention Agenda was developed by the Department of Health and an Ad Hoc Committee made up of a diverse set of stakeholders including local health departments, health care providers, health plans, community-based

organizations, academia, employers, state agencies, schools and businesses.

The Prevention Agenda has five priorities: 1) Prevent Chronic Disease; 2) Promote Healthy and Safe Environments; 3) Promote Healthy Women, Infants and Children; 4) Promote Well-Being and Prevent Substance Use Disorders; and 5) Prevent HIV, Sexually Transmitted Diseases, Vaccine-Preventable Diseases and Healthcare Associated Infections. Each priority area has an action plan that identifies goals and indicators to measure progress and recommended policies and evidence-based interventions.

Cancer-related goals are found throughout the Prevention Agenda, including promoting healthy eating, physical activity, tobacco prevention, and cancer screening; ensuring outdoor air quality and quality drinking water; and mitigating public health risks from hazardous exposures from contaminated sites. More details about the NYS Prevention Agenda can be found at: [https://www.health.ny.gov/prevention/prevention\\_agenda/2019-2024/](https://www.health.ny.gov/prevention/prevention_agenda/2019-2024/).

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## Technical Notes

Figures 1 and 2 used smoothed rates for purposes of clarity. The smoothed values were derived using the Joinpoint software program published by the National Cancer Institute (<https://surveillance.cancer.gov/joinpoint/>). The software finds the best-fit line or lines for a time series, allowing for points of abrupt change known as joinpoints. For this report, up to two joinpoints were allowed. For example, the data for all cancers in Queens as seen in Figure 1 show that there were two joinpoints, one in 2003 when the rate began to increase, and another in 2008 when the rate began to decrease.

Histology categories followed those used by Shi et al.<sup>59</sup> Patients were classified by the histology codes in the International Classification of Disease for Oncology, 3<sup>rd</sup> edition (ICD-O-3) SEER site/histology validation list 2015. Papillary: 8050/3, 8052/3, 8130/3, 8260/3, 8340/3, 8342/3, 8343/3, 8344/3, 8350/3; Follicular: 8330/3, 8331/3, 8332/3, 8335/3; Medullary: 8345/3, 8346/3, 8347/3, 8510/3. Anaplastic: 8021/3. Other: all other codes.

## Appendix A – Description of data sources

The **New York State Cancer Registry** is a population-based cancer incidence registry responsible for the collection of demographic, diagnostic and treatment information on all patients diagnosed with and/or treated for cancer at hospitals, laboratories and other health care facilities throughout New York State. Submission of data is mandated under New York State Public Health Law, section 2401. The Cancer Registry collects a wide variety of information that can be used for research and public health planning and evaluation. Cancer Registry data are routinely used by programs within the Department of Health, county and local health departments, patient advocacy groups, public interest groups, researchers and the public. Because the Registry has collected statewide data since 1976, it can be used to monitor cancer incidence patterns and trends for all areas of New York State.

<http://www.health.ny.gov/statistics/cancer/registry/about.htm>

The **County Population Estimates** used to calculate cancer incidence rates were published by the National Cancer Institute (NCI) for the purposes of national cancer surveillance. They represent a modification of the intercensal and Vintage 2016 annual time series of July 1 county population estimates by age, sex, race and Hispanic origin produced by the U.S. Census Bureau's Population Estimates Program, in collaboration with the National Center for Health Statistics, and with support from the NCI through an interagency agreement.

<https://seer.cancer.gov/popdata/methods.html>

The **New York State Behavioral Risk Factor Surveillance System (BRFSS)** is an annual statewide telephone surveillance system designed by the Centers for Disease Control and Prevention (CDC). New York State has participated annually since 1985. The BRFSS monitors modifiable risk behaviors and other factors contributing to the leading causes of morbidity and mortality in the population. New York State's BRFSS sample represents the non-institutionalized adult household population, aged 18 years and older. Data from the BRFSS are useful for planning, initiating, and supporting health promotion and disease prevention programs at the state and federal level, and monitoring progress toward achieving health objectives for the state and nation.

<http://www.health.ny.gov/statistics/brfss/>

The **Expanded Behavioral Risk Factor Surveillance System (e-BRFSS)**, is a county-level survey that augments the CDC Behavioral Risk Factor Surveillance System (BRFSS). The e-BRFSS is a random-digit-dialed telephone survey of adults 18 years of age and older representative of the non-institutionalized civilian population with landline and cellular telephones living in New York State. The goal of the e-BRFSS is to collect county-specific data on preventive health practices, risk behaviors, injuries and preventable chronic and infectious diseases. Topics assessed by the survey include tobacco use, physical inactivity, diet, use of cancer screening services, and other factors linked to the leading causes of morbidity and mortality. The 2013-14 e-BRFSS was designed with a sampling plan to generate statistically valid county-level estimates for all 57 counties outside New York City, and New York City (n=31,690). The sampling plan resulted in a sufficient sample size to enable calculation of health indicators for several cities in Upstate New

York. In 2016, the e-BRFSS was sampled to produce valid estimates for all 62 counties (n =34,058). Weights were developed for both the 2013-14 and 2016 e-BRFSS to enable the calculation of estimated population rates using a two-stage method developed by CDC.<sup>1</sup> During the first stage, weights reflecting the probability of selection were developed. The sample design yields a complex probability sample because different sampling fractions were used for each county landline frame and region cell phone frame. During the second stage, the weights were raked to US Census county- and region-level administrative control totals for sex, age, race, ethnicity, educational attainment, marital status, owner/renter status, and telephone usage group to help minimize bias due to differential nonresponse patterns (refusal and noncontact) among demographic categories associated with important health risks. For the 2013-14 e-BRFSS, weighting was completed by Clearwater Research.<sup>2</sup> For the 2016 e-BRFSS, CDC calculated the weights.

<https://www.health.ny.gov/statistics/brfss/expanded/>

The **New York State Statewide Planning and Research Cooperative System (SPARCS)** is a comprehensive all payer data reporting system established in 1979 as a result of cooperation between the healthcare industry and government. The enabling legislation for SPARCS is located under Section 28.16 of the Public Health Law (PHL). The regulations pertaining to SPARCS are under Section 400.18 of Title 10 (Health) of the Official Compilation of Codes, Rules, and Regulations of the State of New York (NYCRR). The system was initially created to collect information on discharges from hospitals. SPARCS currently collects patient level detail on patient characteristics, diagnoses and treatments, services, and charges for each hospital inpatient stay and outpatient (ambulatory surgery, emergency department, and outpatient services) visit; and each ambulatory surgery and outpatient services visit to a hospital extension clinic and diagnostic and treatment center licensed to provide ambulatory surgery services.

<https://www.health.ny.gov/statistics/sparcs/>

**Medicaid** is a program for New Yorkers who cannot afford to pay for medical care, administered by the New York State Department of Health. The program maintains a database of medical claims paid by the program. For this report we evaluated trends in neck ultrasounds received by Medicaid patients. For more information about the Medicaid program, see

[https://www.health.ny.gov/health\\_care/medicaid](https://www.health.ny.gov/health_care/medicaid)

**Medicare** is a federal system of health insurance for people over 65 years of age and for certain younger people with disabilities. The program maintains a database of medical claims paid directly by the program, representing about half of total enrollees. For this project we evaluated trends in neck ultrasounds received by a 5% sample of Medicare patients without cancer. For more information about Medicare, see <https://www.medicare.gov>

The **American Community Survey**, conducted by the US Census Bureau, is an ongoing nationwide survey that gathers information on social, economic, housing and demographic characteristics of a population which can be used at many geographic levels such as states, counties, and cities. The data are used by a variety of communities including state and local governments, nongovernmental organizations, and researchers. The data are collected using

four methods: paper questionnaires through the mail, phone interviews, personal visits with a Census Bureau coordinator, and an internet response option. Annually, a sample size of about 3.5 million addresses are randomly selected for participation. Data from the surveys are released in the year immediately following the year in which they are collected. In order to make the data more stable, the Census Bureau combines five consecutive years of ACS data to produce estimates at lower geographic levels, such as census tracts and small towns.

<https://www.census.gov/programs-surveys/acs/>

The **US Environmental Protection Agency's (USEPA) Air Quality System** database contains results of air pollutants measured by air quality monitoring stations across the State in operation at various locations and times. The database contains measurements for criteria pollutants as far back as early 1965 and toxic air pollutants starting in the late 1980s. DOH began the measurements of pollutants in NYS in the mid-1960s and NYS Department of Environmental Conservation (DEC) assumed responsibility for the air quality monitoring network after the agency was established in the early 1970s. DEC has been operating the statewide **Air Toxics Monitoring Network** since 1990. Currently, there are 11 sites statewide collecting 24-hour canister samples for a full suite of volatile organic chemicals in a 1 in 6-day interval. This network has measured air pollutants that are known or likely known to be human carcinogens.

<https://www.epa.gov/aqs>; <https://www.epa.gov/outdoor-air-quality-data>; and <http://www.dec.ny.gov/chemical/8406.html>

The USEPA's **National-scale Air Toxics Assessment (NATA)** provides modeled concentrations and estimated risks for outdoor air pollutants for the years of 1996, 1999, 2002, 2005, 2011 and 2014. Over the years the number of USEPA-designated hazardous air pollutants included in the model has varied from 32 for the 1996 NATA to 180 plus diesel particulate matter for the 2014 NATA. NATA's results help state, local and tribal air agencies identify which pollutants, emission sources and places they may wish to study further to better understand any possible risks to public health from air toxics. Air quality specialists use NATA results to learn which air toxics and emission source types may raise health risks in certain places. However, NATA assessments should not be used to examine trends from one NATA year to another.

<https://www.epa.gov/national-air-toxics-assessment>

The **Radon Program** at the DOH Bureau of Environmental Radiation Protection provides short-term testing kits and results to New York State residents to inform them about radon levels in their homes. The results are entered in the program database and are currently available as maps and tables by county starting in 1987. It is important to note that the database is not a comprehensive record of all tests conducted in NYS and only includes tests requested through the DOH Radon program and outreach efforts by the DOH.

<https://www.health.data.ny.gov/Health/Radon-Test-Results-By-County-Beginning-1987/8e6u-9695>



The **Safe Drinking Water Information System (SDWIS)** is a data system developed by USEPA to store information about public water systems and their violations of the USEPA's drinking water regulations, with the main purpose of keeping public water systems in compliance. States supervise the public water systems within their jurisdictions to ensure that each system meets state and USEPA standards for safe drinking water. NYS currently uses SDWIS as the primary repository for all public water system data.

<https://www3.epa.gov/enviro/facts/sdwis/search.html>

The **Third Unregulated Contaminant Monitoring Rule (UCMR 3)** was published by the USEPA on May 2, 2012. As required by the UCMR 3, USEPA collected data for 30 contaminants suspected to be present in water systems serving 10,000 individuals or more and a select few systems with populations under this limit between 2013 and 2015. This **UCMR 3 (2013-2015) Occurrence Data** shows the number of people potentially being exposed and an estimate of that exposure to these 30 specific contaminants. This information provides the basis for future regulatory actions to protect public health.

<https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule#3>

DEC's **Environmental Site Remediation Database** contains records of the sites which are under remediation or are being managed by the agency. All sites listed under the State Superfund, Brownfield Cleanup, Environmental Restoration and Voluntary Cleanup programs, as well as, the Registry of Inactive Hazardous Waste Disposal Sites are included in this database.

<https://www.dec.ny.gov/chemical/8437.html>

The New York State Department of Transportation (DOT) operates a **Traffic Monitoring Program** which collects information on traffic counts at fixed and temporary monitoring locations. This information is processed to create average annual daily traffic (AADT) counts for road segments along interstate highways and all NYS routes and roads that are part of the Federal Aid System. Computer software is used to link datasets with AADT with road segment locations.

<https://www.dot.ny.gov/divisions/engineering/technical-services/highway-data-services>

### **Sources of data for air quality evaluation**

#### *Background*

An air pollutant is a substance (such as a chemical, dust, smoke, or pollen) that is present in air as a solid (particulate), gas (vapor) or liquid (mist), or a combination of these. Air pollution is the presence of those substances in the air at levels (concentrations) greater than would normally be found or considered desirable. It comes from many different human sources such as cars, buses, trucks, factories, power plants and dry cleaners, as well as natural sources such as vegetation, windblown dust, and wildfires. Although air pollution is typically thought of as an outdoor air problem, sources also exist inside homes and places of work. Examples include tobacco smoke, home heating appliances, new carpeting, household products (such as air fresheners, paints, cleansers, and pest-control agents), and personal care products (such as perfumes, deodorants, lotions, and hair-care products).

New York developed an air pollution control program over 60 years ago. In 1957, the New York State Legislature enacted one of the nation's first comprehensive air pollution control laws by passing the Air Pollution Control Act, formerly Article 12-A of the Public Health Law. The Law recognized the need “to safeguard the air resources of the state from pollution” by controlling or abating air pollutant releases from existing sources and preventing new source releases for the public good. The State’s policy was then and remains: “to maintain a reasonable degree of purity of the air resources of the state, which shall be consistent with public health and welfare and the public enjoyment thereof, the industrial development of the state...” By 1962 this policy provided the foundation for an air pollution control program to control emissions from industrial processes and the combustion of fuels in New York.

Since the 1970 Clean Air Act, the US Environmental Protection Agency (USEPA) has been regulating “criteria” air pollutants which are carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, ozone, and lead through National Ambient Air Quality Standards (NAAQS). Two types of Standards were established. The Primary Standards are designed to protect human health with an adequate margin of safety and Secondary Standards are designed to protect public welfare, including protection against decreased visibility and damage to animals, crops, and buildings. Additional information about criteria pollutants is available on the USEPA’s web site at <https://www.epa.gov/criteria-air-pollutants>.

In 1990, the Clean Air Act was amended to include a list of “hazardous air pollutants” selected by Congress based on potential health and/or environmental hazard. The original list included 188 hazardous air pollutants (HAPs) such as benzene, which is found in gasoline; tetrachloroethene (PERC), which is emitted from dry cleaning facilities; methylene chloride, which is used as a solvent and paint stripper; and some metals such as cadmium, mercury, and chromium. The current list includes 187 HAPs. The Clean Air Act requires USEPA to regulate emissions of HAPs from a list of industrial sources called “source categories” (e.g., boat manufacturing, gasoline distribution, and municipal and hazardous waste combustors). Additional information about HAPs is available on the USEPA’s web site at <https://www.epa.gov/haps>.

New York State Department of Environmental Conservation (DEC) establishes both short-term and long-term air concentration guideline values for toxic air pollutants (including the subset known as USEPA-designated Hazardous Air Pollutants (HAPs)) by adopting the most health-protective, scientifically valid, value developed by DEC, USEPA, NYS Department of Health (DOH) or other authoritative agencies. DEC uses these values as part of its strategy to determine the degree of pollutant removal required for sources releasing toxic air pollutants. Short-term air concentration guideline values (SGCs) are derived to protect the general public from adverse exposure to toxic air pollutants during short-term exposures of 1-hour. Long-term (annual) guideline concentrations (AGCs) are derived to protect the general public from chronic health effects during a lifetime of continuous exposure.

#### *Air Quality Monitoring Data*

The *USEPA’s Air Quality System* database contains data from air quality monitoring stations

across the State in operation at various locations and times since 1965. The database contains measurements for criteria pollutants as far back as early 1965 and toxic air pollutants starting in the late 1980s. DOH began the measurements of pollutants in New York State in the mid-1960s and DEC assumed responsibility for the air quality monitoring network after the agency was established in the early 1970s.

The criteria air pollutants measured include sulfur dioxide, ozone, carbon monoxide, nitrogen dioxide, and lead, total suspended particulates and particulate matter less than 2.5 and 10 microns (PM<sub>2.5</sub> & PM<sub>10</sub>) in diameter. Even though toxicological data do not indicate that these pollutants are environmental risk factors for cancer, DOH researchers are using the criteria pollutants since they provide the longest historical measurements of air pollution. The criteria pollutants have been co-released with other air pollutants that could be potential carcinogens for which there are no historical measurements. Further work could be conducted to determine the utility of using historical measurements of criteria pollutants as surrogates or indicators of exposure to potential carcinogens. For the purposes of this evaluation, staff looked at trends over time for each of the criteria air pollutants.

DEC has been operating a statewide *air toxics monitoring network* since 1990. Currently, there are 11 sites statewide collecting 24-hour canister samples for a full suite of volatile organic chemicals in a 1 in 6-day interval. This network has measured air pollutants that are known or likely known to be human carcinogens which will be included in this assessment. The initial development of this network was part of the Staten Island/New Jersey Urban Air Toxics Assessment Project which began in 1987 on Staten Island. Information from this early study has been compiled for review as part of this Initiative. In some cases, monitor data may not be available for the study areas. In these cases, staff reviewed and, where appropriate, summarized data from nearby monitors as an indicator of exposures in the Study Area. More information on DEC's air monitoring program and data can be found on-line at: <http://www.dec.ny.gov/chemical/8406.html>

#### *Air Quality Modeled Concentrations*

USEPA estimated chemical-specific air concentrations for small geographic areas known as census tracts across the US. This program is called the National-scale Air Toxics Assessment (see: <https://www.epa.gov/national-air-toxics-assessment>). Over the years the number of USEPA-designated HAPs included in the model has varied from 32 for the 1996 NATA to 180 plus diesel particulate matter for the 2014 NATA. USEPA obtained emissions data (i.e., for the years 2011 and 2014) from state sources, the Toxic Release Inventory, the National Emissions Inventory, and other databases. USEPA developed outdoor air concentrations using a complex computer program (called a dispersion model) that merges the emissions data with meteorological data, such as wind speed and wind direction, to estimate pollutant concentrations in ambient air. This model accounted for emissions from large industrial facilities, such as power plants and manufacturing facilities, and smaller facilities, such as dry cleaners and gas stations. USEPA included emissions from mobile sources such as motor vehicles, trains, planes/airports, ports and boats, and emissions from farming and construction equipment in the modeling estimates. USEPA also accounted for secondary formation of

pollutants through photochemical mechanisms and pollution due to residential wood burning, wildfires, agricultural burning, and structural fires.

For this evaluation, DOH researchers evaluated HAPs from the 2011 and 2014 NATA. First, HAPs which are considered known or likely human carcinogens based on authoritative review from agencies such as the International Agency for Research on Cancer, USEPA's Integrated Risk Information System and US Department of Health and Human Services' National Toxicology Program, were selected for consideration. Next, HAPs, for which the NATA cancer risk estimate was above the theoretical (probability-based) cancer risk level of "one excess cancer case in a population of one-million" or "one-in-one-million," were selected for consideration. Because many of the pollutants evaluated in NATA have low modeled concentrations and small cancer risks, the list of HAPs for consideration was reduced to five: 1,3-butadiene, acetaldehyde, benzene, carbon tetrachloride and formaldehyde.

Moving forward, DOH researchers could apply the same approach to earlier versions of NATA. However, it should be noted that earlier versions of NATA do not have the same data quality as the 2011 and 2014 versions.

#### *Air Quality Permit and Inventory Data*

The DEC air permitting information and inventory data can be used to conduct a retrospective analysis of exposure to carcinogenic air contaminants in the selected study areas. Facilities that are major sources of air pollution are required to report their emissions of criteria pollutant and HAPs on an annual basis. These facilities are permitted under the federal Title V air permit program. Emissions inventory information from these Title V permitted facilities has been collected since 1993 and is available in the DEC Air Facility System (AFS). DEC also issues State Facility permits and registrations. Emissions information for HAPs and other air contaminants are collected on the individual state facility permits. Registrations are issued for small sources of air pollution and emission information collected on the registration forms are extremely limited. Prior to the 1990 Clean Air Act and advent of the Title V operating permit program, DEC's Division of Air Resources issued certificates to operate for all stationary sources of air pollution which in many cases contained emissions information of pollutants by their chemical abstract service registry number. This historic air permit information is retained in the DEC AFS Historic Data Module.

#### *Special Studies*

Special studies about air quality are conducted in various localities across the State. These studies usually are conducted in response to public complaints. Additional work could determine if any special air quality studies have been conducted in the four study areas and if the information is available.

### **Source of data for radon evaluation**

#### *Background*

Radon is present everywhere, but some areas are at a higher risk due to their underlying

geology. Radon in homes is the largest source of radiation exposure to the general public. Most inhaled radon is rapidly exhaled, but the decay products can deposit in the lung. These radioactive particles can cause damage to cells lining the airways, increasing the risk of lung cancer. Homes with high radon concentrations increase their occupants' risk of developing lung cancer. According to the USEPA, radon is the second leading cause of lung cancer following smoking, and the leading cause of lung cancer among non-smokers. Exposure to radon among tobacco smokers greatly increases the risk of lung cancer more than exposure to either radon or smoking alone. Radon is responsible for about 21,000 lung cancer deaths every year, about 2,900 of which occur among people who have never smoked.

There are currently no laws in NYS that require residential radon testing or mitigation of elevated radon levels. The only way to determine radon levels in a home is to test. Although the potential for a home to have an elevated radon level can be estimated, testing is the only to know for sure. Radon tests can be short-term tests (less than 90 days, typically 2 to 7 days) or long-term tests (3 to 12 months). Short-term tests are useful for screening and for situations where results are needed quickly. The charcoal canister (CC) is most commonly used device for short-term radon measurements in homes. The device contains activated charcoal that adsorbs radon in air and the decay products can then be measured by a laboratory. Another type of short-term test is the continuous electronic radon monitor which generally produces more precise radon measurements and are more tamper resistant than charcoal canisters. Radon levels have been found to change during the day. Levels can also vary due to temperature changes and season and are generally higher in the winter. Long-term tests are therefore considered a better indicator of indoor radon levels as they can provide a true annual average. A commonly used long-term detector is the Alpha Track (AT) detector. When the radon level in the lowest primary living area of the home is above USEPA's action level of 4 picocuries per liter of air (pCi/L), the DOH recommends that the homeowner take appropriate corrective action.

#### *Radon in indoor air monitoring data*

The Radon Program at the DOH Bureau of Environmental Radiation Protection provides short-term testing kits and results to New York State residents to inform them about radon levels in their homes. The results are entered in the program database and are currently available as maps and tables by county starting in 1987 (<https://www.health.data.ny.gov/Health/Radon-Test-Results-By-County-Beginning-1987/8e6u-9695>). It is important to note that the database is not a comprehensive record of all tests conducted in NYS and only includes tests requested through the DOH Radon program and outreach efforts by the DOH.

For this evaluation, the DOH aimed to characterize radon test results from 1987 to 2015. Researchers used radon data from tests conducted during this period (excluding tests performed at schools and day care centers), to estimate various measures for the Staten Island study area and comparison areas including NYS, and NYS excluding NYC. The summary measures of radon test results evaluated for each study and comparison area include: total number of tests conducted, average and maximum test values and percent of tests that were at or above the action level of 4 pCi/L. We also determined number of tests and average radon values by floor level (basement and first floor) in each of the areas. DOH staff also prepared a

map for Staten Island to display average radon levels by census block. Researchers also compared study area radon test data with other geographic areas mentioned above.

#### *Resources for Radon*

- NYS Cancer Registry and Cancer Statistics:  
<https://www.health.ny.gov/statistics/cancer/registry/>
- Cancers and Their Risk Factors:  
<https://www.health.ny.gov/statistics/cancer/registry/abouts/>
- Environmental Facilities and Cancer Mapping:  
[https://apps.health.ny.gov/statistics/cancer/environmental\\_facilities/mapping/map/](https://apps.health.ny.gov/statistics/cancer/environmental_facilities/mapping/map/)
- Radiological Health/ Radon  
<https://www.health.ny.gov/environmental/radiological/radon/>
- A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon. <https://www.epa.gov/radon/citizens-guide-radon-guide-protecting-yourself-and-your-family-radon>
- USEPA's "Consumer's Guide to Radon Reduction".  
[https://www.epa.gov/sites/production/files/2016-12/documents/2016\\_consumers\\_guide\\_to\\_radon\\_reduction.pdf](https://www.epa.gov/sites/production/files/2016-12/documents/2016_consumers_guide_to_radon_reduction.pdf)
- USEPA "Building Radon out" <https://www.epa.gov/sites/production/files/2014-08/documents/buildradonout.pdf>

#### **Sources of data for drinking water evaluation**

##### *Background*

A public water system is an entity which provides water to the public for human consumption through pipes or other constructed conveyances. In New York, any system with at least five service connections or that regularly serves an average of at least 25 people daily for at least 60 days out of the year is considered a public water system. Public water systems are categorized as one of the following types of systems: community and non-community (including non-transient non-community and transient non-community). For this assessment, community and non-transient non-community water sources were examined. A community water system is a public water system that serves the same people year-round. Most residences, including homes, apartments, and condominiums, in cities, towns, and mobile home parks are served by community water systems. Examples of community water systems include municipally-owned (cities, towns, or villages) public water supplies, public water authorities, or privately-owned water suppliers such as homeowner associations, apartment complexes, and mobile home parks that maintain their own drinking water system. A non-transient non-community water system is a water system that serves the same people more than six months per year, but not year-round. Schools, colleges, hospitals and factories with their own water supplies are examples of non-transient non-community water systems. Community and non-transient non-community water resources relate to prolonged daily use of that water, and as such will have greater exposure to analytes if present.

Staten Island is served entirely by the Catskill/Delaware Watersheds of the New York City Water Supply System.

### *Drinking Water Standards*

New York State and the federal government regulate public drinking water systems to protect public health. Regulations have evolved over time for a variety of principal organic compounds (POCs), metals, pesticides, pathogens, and other contaminants. In 1974, Congress passed the Safe Drinking Water Act that standardized the protection of drinking water on a national level. States that previously had established drinking water standards were required to make their standards at least as stringent as the national standards promulgated by the USEPA. These national drinking water standards first went into effect in 1977.

Violations of these regulations occur when federally (USEPA) established Maximum Contaminant Levels (MCLs) are surpassed. In certain cases, MCLs refer to a running average of samples over a quarterly time frame, meaning an individual exceedance of an MCL may not warrant a violation. Rather, an exceedance occurring over a certain time frame that reaches a mean value above that of the Maximum Contaminant Level, would trigger a violation.

DOH researchers evaluated three data sources to assess historical chemical contamination of public and private drinking water (where possible) in the four selected study areas. These analytical datasets, though providing some of the best proxies for exposure in study areas, have been collected for a variety of purposes, including regulatory, compliance, and targeted responses to specific needs to address contamination issues. These data sources are described as follows:

### *Safe Drinking Water Information System (1999-2018)*

The Safe Drinking Water Information System (SDWIS) is a data system developed by USEPA to store information about public water systems and their violations of the USEPA's drinking water regulations, with the main purpose of keeping public water systems in compliance. These guidelines establish maximum contaminant levels, treatment techniques, and monitoring and reporting requirements that ensure water systems provide safe water to their customers. Data management plays a critical role in helping states and the USEPA protect public health. States supervise the public water systems within their jurisdictions to ensure that each system meets state and USEPA standards for safe drinking water. New York State currently uses SDWIS as the primary repository for all public water system data. The Safe Drinking Water Act requires states to report drinking water information periodically to the USEPA. This was a primary source for the sampling and contaminant data used in this study.

What information is included in the SDWIS Database?

- Basic information about each public water system, including:
  - the system's name
  - ID number
  - city or county served
  - number of people served

- type of system (community, non-transient non-community, etc.)
- whether the system operates year-round or seasonally
- characteristics of the system's source(s) of water (ground water, surface water, etc.)
- Violation information for each public water system, including whether the system has:
  - failed to follow established monitoring and reporting schedules
  - failed to comply with mandated treatment techniques
  - violated any Maximum Contaminant Levels (MCLs)
  - failed to communicate required information to their customers
- Enforcement information, including actions the state or USEPA have taken to ensure that a public water system returns to compliance if it is in violation of a drinking water regulation.

Table 1 lists all analytes in seven categories based on their properties that were examined for the evaluation of potential unusual exposures via public drinking water systems.

**Table A1. List of analytes in the Safe Drinking Water Information System**

<b>Principal Organic Compounds (POCs)</b>	
1,1-DICHLOROETHANE	DICHLOROMETHANE
1,1-DICHLOROETHYLENE	ETHYLBENZENE
1,1-DICHLOROPROPENE	HEXACHLOROBUTADIENE
1,1,1-TRICHLOROETHANE	ISOPROPYLBENZENE
1,1,1,2-TETRACHLOROETHANE	M-DICHLOROBENZENE
1,1,2-TRICHLOROETHANE	META-XYLENE
1,1,2,2-TETRACHLOROETHANE	METHYL TERT-BUTYL ETHER
1,2-DICHLOROETHANE	N-BUTYLBENZENE
1,2-DICHLOROPROPANE	N-PROPYLBENZENE
1,2,3-TRICHLOROBENZENE	O-CHLOROTOLUENE
1,2,3-TRICHLOROPROPANE	O-DICHLOROBENZENE
1,2,4-TRICHLOROBENZENE	ORTHO-XYLENE
1,2,4-TRIMETHYLBENZENE	P-CHLOROTOLUENE
1,3-DICHLOROPROPANE	P-DICHLOROBENZENE
1,3,5-TRIMETHYLBENZENE	P-ISOPROPYLTOLUENE
2,2-DICHLOROPROPANE	PARA-XYLENE
BENZENE	SEC-BUTYLBENZENE
BROMOBENZENE	STYRENE
BROMOCHLOROMETHANE	TERT-BUTYLBENZENE
BROMOMETHANE	TETRACHLOROETHYLENE
CARBON TETRACHLORIDE	TOLUENE
CHLOROBENZENE	TRANS-1,2-DICHLOROETHYLENE
CHLOROETHANE	TRANS-1,3-DICHLOROPROPENE
CHLOROMETHANE	TRICHLOROETHYLENE
CIS-1,2-DICHLOROETHYLENE	TRICHLOROFUOROMETHANE
CIS-1,3-DICHLOROPROPENE	VINYL CHLORIDE



DIBROMOMETHANE	XYLENE, META AND PARA
DICHLORODIFLUOROMETHANE	XYLENES, TOTAL
<b>Nitrates (NITs)</b>	
NITRATE	NITRITE
NITRATE-NITRITE	
<b>Primary Inorganic Compounds (PICs)</b>	
ANTIMONY, TOTAL	MANGANESE
ARSENIC	IRON + MANGANESE
BARIUM	MERCURY
BERYLLIUM, TOTAL	NICKEL
CADMIUM	ODOR
CHLORIDE	SELENIUM
CHROMIUM	SILVER
COLOR	SULFATE
CYANIDE	THALLIUM, TOTAL
FLUORIDE	ZINC
IRON	
<b>Synthetic Organic Compounds (SOCs)</b>	
2,3,7,8-TCDD	DINOSEB
2,4-D	ENDRIN
2,4,5-TP	ETHYLENE DIBROMIDE
3-HYDROXYCARBOFURAN	HEPTACHLOR
ALDICARB	HEPTACHLOR EPOXIDE
ALDICARB SULFONE	HEXACHLOROBENZENE
ALDICARB SULFOXIDE	HEXACHLOROCYCLOPENTADIENE
ALDRIN	LASSO
ATRAZINE	METHOMYL
BENZO(A)PYRENE	METHOXYCHLOR
BHC-GAMMA	METOLACHLOR
BUTACHLOR	METRIBUZIN
CARBARYL	OXAMYL
CARBOFURAN	PENTACHLOROPHENOL
CHLORDANE	PICLORAM
DALAPON	PROPACHLOR
DI(2-ETHYLHEXYL) ADIPATE	SIMAZINE
DI(2-ETHYLHEXYL) PHTHALATE	TOTAL POLYCHLORINATED BIPHENYLS (PCB)
DICAMBA	TOXAPHENE
DIELDRIN	
<b>Radiological Samples (RADs)</b>	
COMBINED RADIUM (-226 & -228)	RADIUM-228
GROSS ALPHA PARTICLE ACTIVITY	THORIUM
GROSS BETA PARTICLE ACTIVITY	URANIUM

RADIUM-226	
<b>Disinfection by Products (DBP9)</b>	
TOTAL HALOACETIC ACIDS (HAA5)	TOTAL TRIHALOMETHANES (TTHM)
<b>Lead and Copper (PBCU)</b>	
COPPER	LEAD

*Unregulated Contaminant Occurrence Data (2013-2015)*

Data for unregulated contaminants is provided through the 3<sup>rd</sup> Unregulated Contaminant Monitoring Rule (UCMR 3), which was published by the USEPA on May 2, 2012. It required monitoring for 30 contaminants in drinking water for all systems serving a population over 10,000 and a select few systems with populations under this limit. Table 2 lists these UCMR 3 contaminants. Unregulated contaminant occurrence data is gathered by observing public water systems for contaminants, providing the USEPA and other interested parties with nationally representative data on the occurrence of contaminants in drinking water. Additionally, this dataset shows the number of people potentially being exposed and an estimate of that exposure. This information provides the basis for future regulatory actions to protect public health.

**Table A2. List of 30 contaminants in the 3rd Unregulated Contaminant Monitoring Rule**

<b>Chemicals</b>	
1,2,3-trichloropropane	chlorate
1,3-butadiene	perfluorooctanesulfonic acid (PFOS)
methyl chloride	perfluorooctanoic acid (PFOA)
1,1-dichloroethane	perfluorononanoic acid (PFNA)
methyl bromide	perfluorohexanesulfonic acid (PFHxS)
chlorodifluoromethane (HCFC-22)	perfluoroheptanoic acid (PFHpA)
bromochloromethane (Halon 1011)	perfluorobutanesulfonic acid (PFBS)
1,4-dioxane	17 $\beta$ -estradiol
vanadium	17 $\alpha$ -ethynylestradiol (ethinyl estradiol)
molybdenum	16- $\alpha$ -hydroxyestradiol (estriol)
cobalt	equilin
strontium	estrone
total chromium	testosterone
chromium-6	4-androstene-3,17-dione
<b>Viruses</b>	
enteroviruses	noroviruses

*Spatially-referenced datasets*

In addition to the datasets that were listed above, spatial data were also used as part of this evaluation. These data sources were used to delineate public water service areas and to provide specific well locations and associated sample data. Water district and pressure zone boundaries were developed by DOH researchers based on water distribution records.

### **Sources of data for traffic evaluation**

DOH researchers reviewed information from NYS Department of Transportation (DOT) traffic monitoring program. This program collects information on traffic counts at fixed and temporary monitoring locations. DOH used this data to assess how traffic in the Study Area compares to traffic in other areas of NYS. This information is processed to create average annual daily counts of traffic for road segments along interstate highways and all NYS routes and roads that are part of the Federal Aid System.

## Appendix B – Long term time trends for criteria air pollutant concentrations for Staten Island monitoring locations

Figure B1. Trends in Particulate Matter (<10 microns) Annual Average Concentrations for Staten Island (current NAAQS = 150 mcg/m<sup>3</sup>)

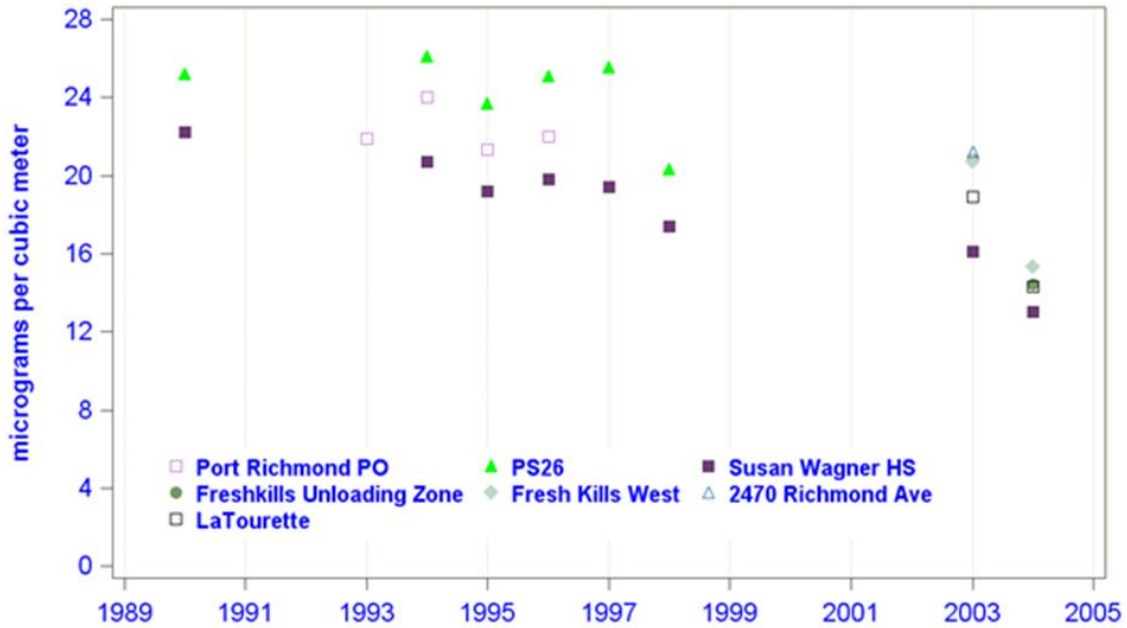


Figure B2. Trends in Particulate Matter (<2.5 microns) Annual Average Concentrations for Staten Island (current NAAQS = 12 mcg/m<sup>3</sup>)

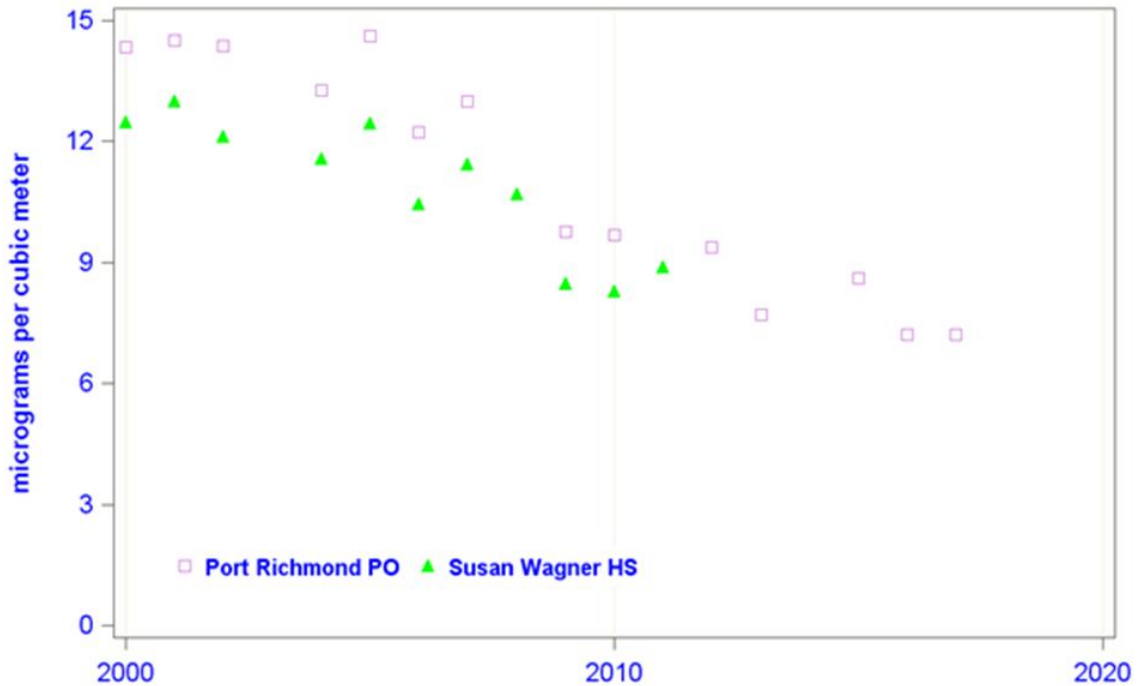
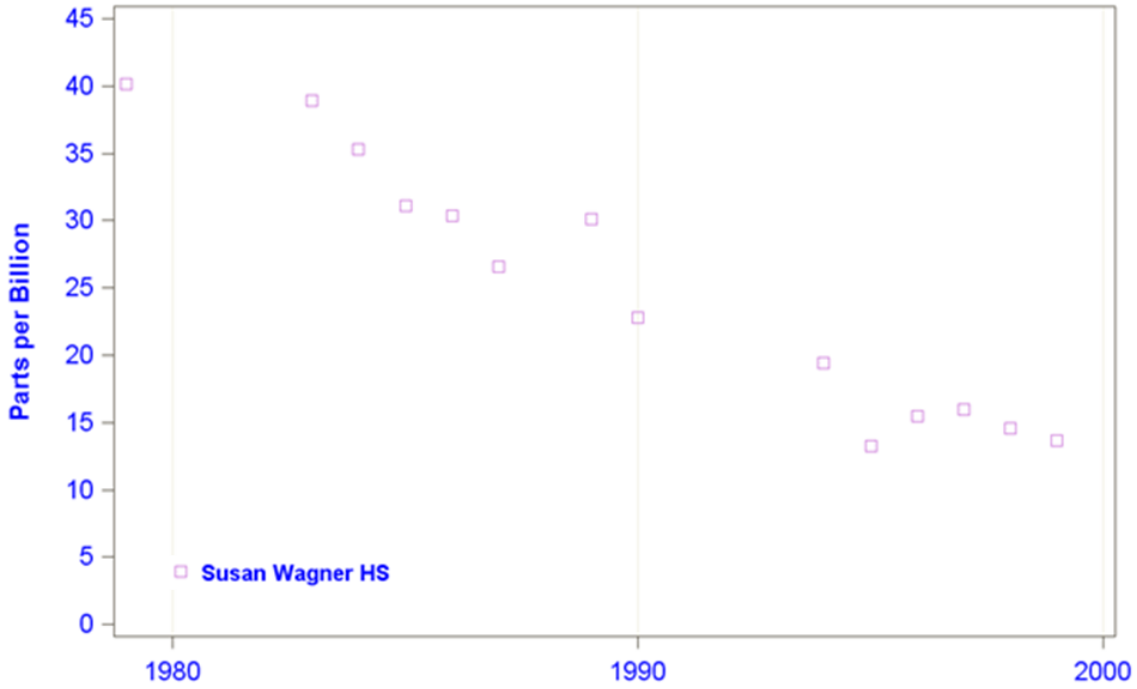


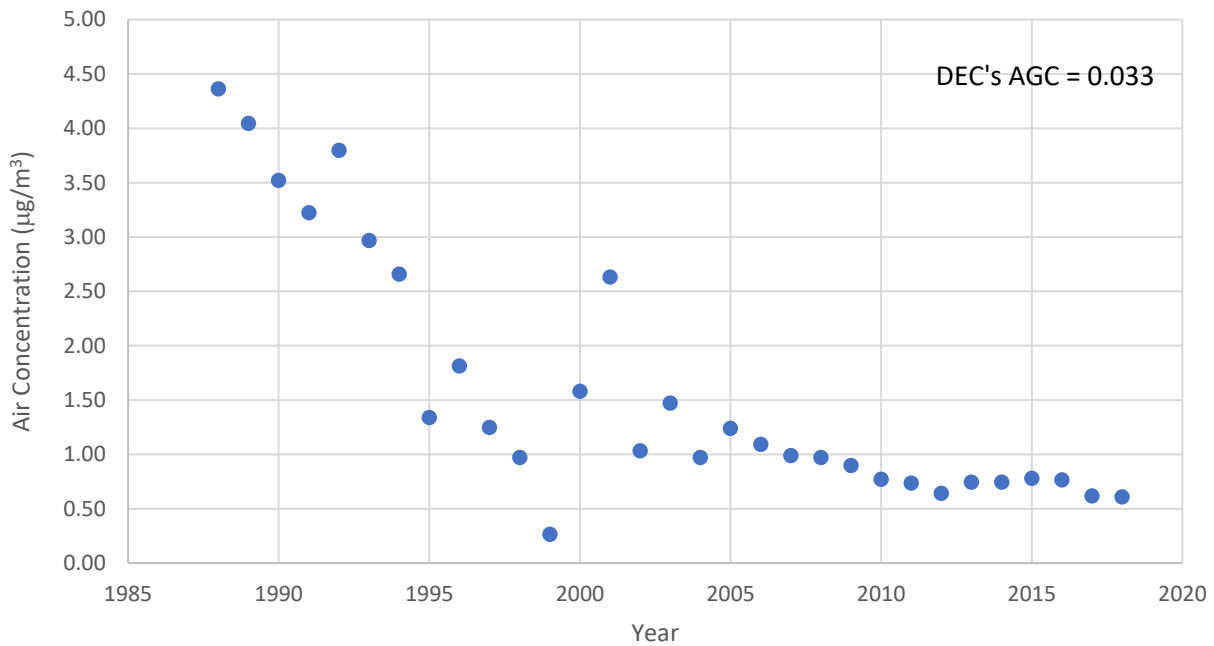
Figure B3. Trends in Sulfur Dioxide Annual Average Concentrations for Staten Island (There is not currently a NAAQS based on annual-averages)



# Appendix C – Toxicological information for primary air toxic risk drivers in Staten Island

## 1,3-Butadiene

Figure C1. Trends in Ambient Air Concentrations of 1,3-Butadiene Measured at Staten Island Stations.



According to the Toxicological Profile for 1,3-butadiene published by the Agency for Toxic Substances and Disease Registry (ATSDR), 1,3-butadiene is released from industrial sources, automobile exhaust, cigarette smoke and the burning of wood and rubber/plastic (ATSDR, 2012).

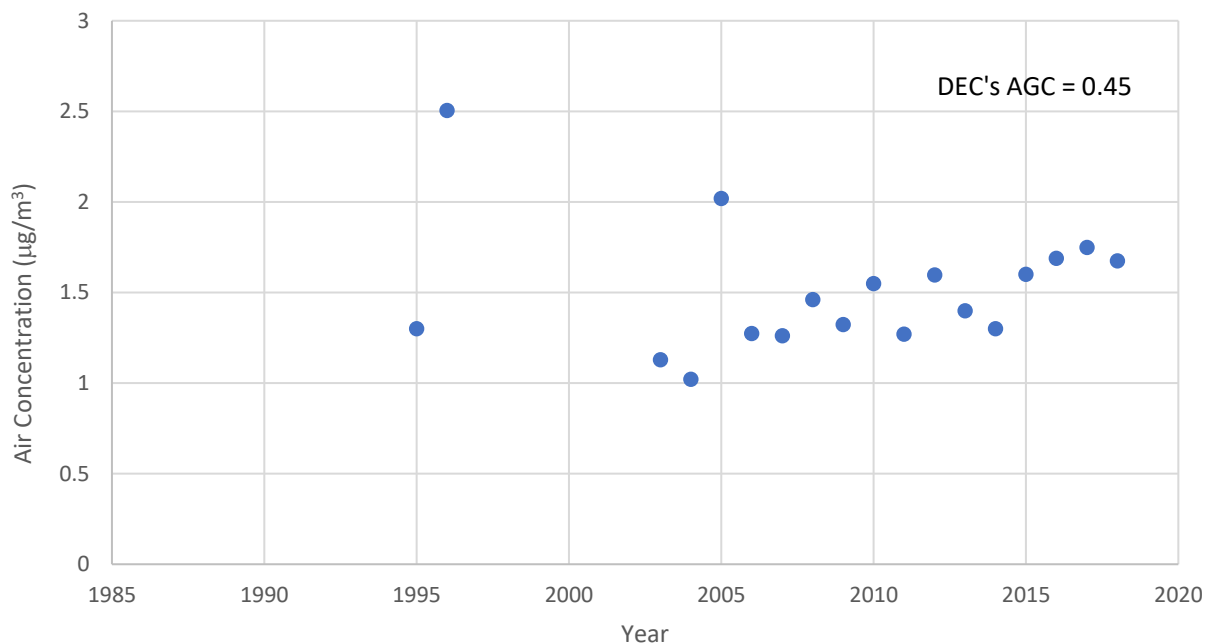
The USEPA, National Toxicology Program (NTP) and International Agency for Research on Cancer (IARC) classify this chemical as carcinogenic to humans. This classification is based on sufficient evidence from epidemiologic studies of workers exposed to 1,3-butadiene that show an increased incidence of cancers of the blood and lymphatic system but exposure information for these studies is lacking (ATSDR, 2012). Animal studies provide additional evidence of carcinogenicity. 1,3-Butadiene is associated with several non-cancer effects as well.

Typical ambient air concentrations of 1,3-butadiene in urban air range from 0.1 to 2 micrograms per cubic meter of air ( $\text{mcg}/\text{m}^3$ ) (ATSDR, 2012). The levels measured between 1995 and 2017 on Staten Island are consistent with these concentrations, however, past concentrations measured in 1987 to 1993 were higher than expected background and higher compared to other DEC monitoring stations. DEC's AGC ( $0.033 \text{ mcg}/\text{m}^3$ ) is based on the air concentration associated with a one-in-one-million excess cancer risk for long-term exposure.

Although measured concentrations in air are above DEC's AGC, exposure to this chemical in outdoor air is estimated to pose a low risk of cancer over a lifetime.

## Acetaldehyde

**Figure C2. Trends in Ambient Air Concentrations of Acetaldehyde Measured at Staten Island Stations.**



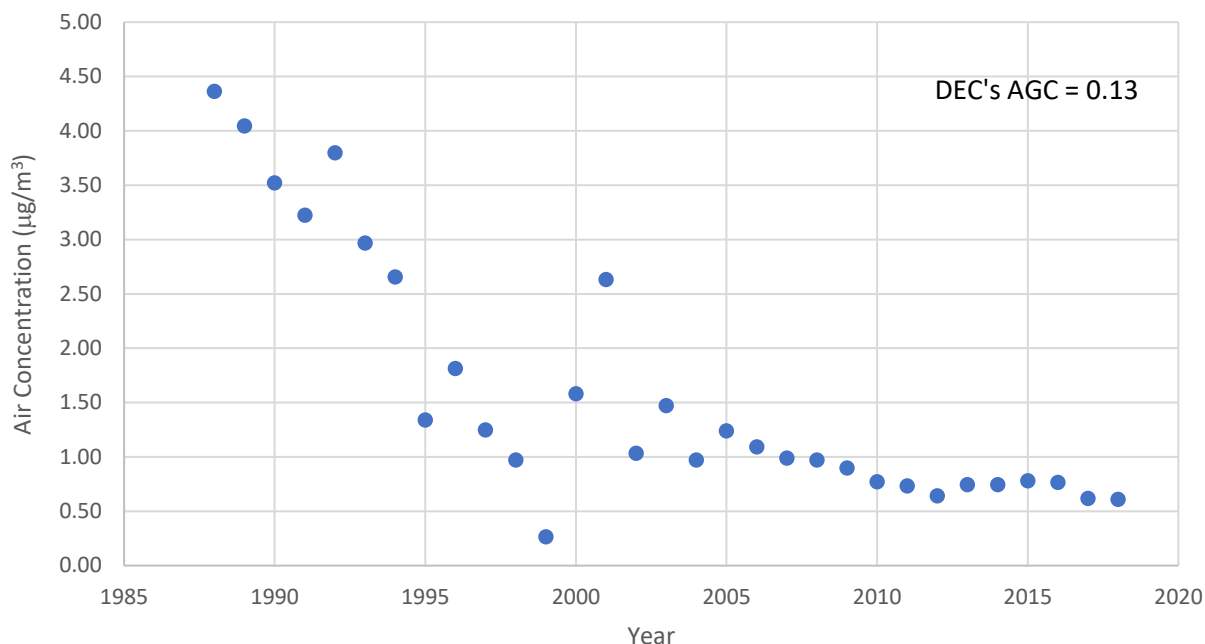
People are exposed to small amounts of acetaldehyde each day. Acetaldehyde is used in the chemical manufacturing industry and in numerous consumer products, including perfumes. It is found in tobacco, wood smoke and vehicle exhaust. It is also used as a flavoring agent, as allowed by the Food and Drug Administration and is found in trace amounts in many plant products that people eat (NTP, 1991). According to the National Toxicology Program (NTP), most people's exposure to acetaldehyde is through the consumption of alcoholic beverages.

The NTP states that acetaldehyde is reasonably anticipated to be a human carcinogen based on sufficient evidence in animal studies. Similarly, USEPA classifies acetaldehyde as a probable human carcinogen based on sufficient evidence in animals (USEPA, 1998). Whether or not acetaldehyde causes cancer in humans is unknown. Animal studies have identified increased incidence of nasal and laryngeal tumors caused by long-term inhalation of high concentrations of acetaldehyde.

The concentrations of acetaldehyde measured on Staten Island (ranging from 1 to 2.5 mcg/m<sup>3</sup>) are similar to those measured at other urban areas (0.7 – 5.2 mcg/m<sup>3</sup>) (HEI, 2007). However, the measured levels are above DEC's AGC, which is based on the air concentration associated with a one-in-one-million excess cancer risk for long-term exposure. Thus, exposure to this chemical in outdoor air is estimated to pose a low risk of cancer over a lifetime.

## Benzene

**Figure C3. Trends in Ambient Air Concentrations of Benzene Measured at Staten Island Stations.**



Benzene is widely used in the US and ranks in the top 20 chemicals for US production volume, according to the ATSDR's Toxicological Profile (ATSDR, 2007). ATSDR reports that the major sources of benzene exposure are tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions, including petrochemical plants and coke ovens. There are also natural sources of benzene. People living in urban environments are exposed to more benzene than those residing in rural areas. ATSDR's 2007 ToxGuide for benzene indicates that the mean benzene concentration in urban air is 0.58 ppb (equivalent to 1.9 mcg/m<sup>3</sup>). Benzene levels indoors are usually higher than outdoors (ATSDR, 2007).

Benzene has been classified as a known human carcinogen by NTP, USEPA and IARC. Toxicologists at these agencies conclude that benzene is a human carcinogen based on sufficient inhalation data in humans that is also supported by animal evidence. According to the ATSDR, the human cancer caused by inhalation exposure to benzene is predominantly leukemia, especially acute nonlymphocytic (myelocytic) leukemia, whereas benzene exposure in animal studies causes multiple cancer sites by both the inhalation and oral routes of exposure. Long-term inhalation of high levels of benzene can also cause hematological, immunological and neurological effects.

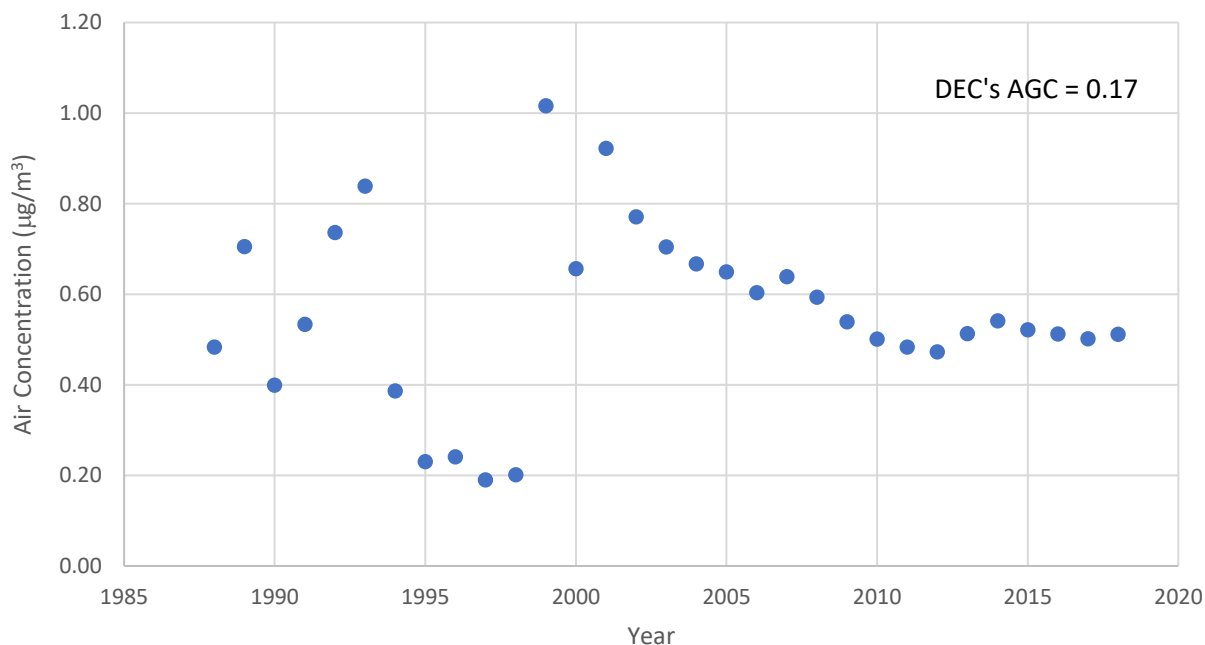
Except for the rural background measurements collected at Whiteface Mountain, annual-average concentrations of benzene measured at DEC's statewide monitoring network are above the DEC's health-based AGC (0.13 mcg/m<sup>3</sup>). On Staten Island, where air monitors were sited



downwind from known benzene refinery sources, benzene concentrations were elevated in the past compared to other locations. However, due to regulatory actions, recent benzene air monitoring data for Staten Island are comparable to other urban areas in NYS. DEC's AGC is based on the air concentration associated with a one-in-one-million excess cancer risk for long-term exposure. The measured levels of benzene are estimated to pose a low risk of cancer over a lifetime.

## Carbon Tetrachloride

**Figure C4. Trends in Ambient Air Concentrations of Carbon Tetrachloride Measured at Staten Island Stations.**



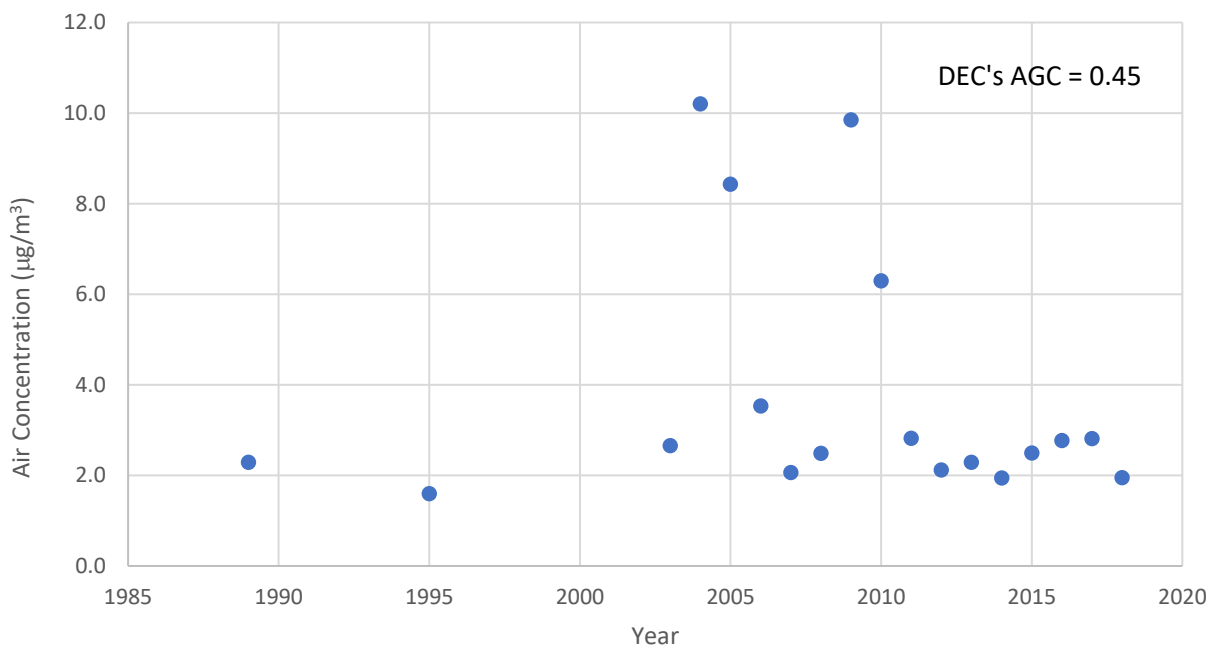
Carbon tetrachloride is an industrial chemical that does not occur naturally. According to the ATSDR, it was used primarily as a refrigerant and aerosol propellant but also as a pesticide, degreaser, cleaning agent, in fire extinguishers and as a spot remover. Because of its ozone-depleting potential, manufacture and use of carbon tetrachloride was banned (phased-out) with the Montreal Protocol (adopted in 1987). Because the chemical is very stable, it stays in the air for long periods of time without breaking down. Carbon tetrachloride is found in outdoor and indoor air (ATSDR, 2005).

Occupational studies of carbon tetrachloride indicate that human exposure to high levels of this chemical can cause neurological effects (*e.g.*, intoxication, dizziness, headache, sleepiness) and can damage the liver and kidney (ATSDR, 2007). High levels of exposure to carbon tetrachloride in air causes an increased incidence of liver tumors in animal studies (ATSDR, 2007). As such, the USEPA, IARC and NTP have classified this chemical as “likely to be carcinogenic,” “possibly carcinogenic,” and “reasonably anticipated to be a human carcinogen,” respectively. Whether or not carbon tetrachloride causes cancer in humans is unknown.

Measured concentrations on Staten Island (ranging from 0.23 to 1.02 mcg/m<sup>3</sup>) are consistent with the measured levels described in ATSDR's Toxicological Profile (urban areas ranging from 0.45 to 1.83 mcg/m<sup>3</sup>). Although the measured levels exceed DEC's AGC (0.17 mcg/m<sup>3</sup>), which is based on a one-in-one-million excess cancer risk for long-term exposure, the concentrations are estimated to pose a low risk of cancer over a lifetime.

## **Formaldehyde**

**Figure C5. Trends in Ambient Air Concentrations of Formaldehyde Measured at Staten Island Stations.**



According to the ATSDR, everyone is exposed to small amounts of formaldehyde in air and in some foods and consumer products (ATSDR, 1999). The main source of formaldehyde in the atmosphere is believed to be from photo-oxidation of hydrocarbon combustion products and studies have demonstrated that daily variations in outdoor formaldehyde concentrations correlate with traffic conditions (ATSDR, 1999; ATSDR, 2010).

Formaldehyde irritates the eyes, throat and respiratory system and also can cause neurological effects if people are exposed to sufficient amounts. An increased incidence of respiratory tract tumors, including squamous cell tumors, is seen in animals exposed to high levels of formaldehyde. As such, the USEPA classifies formaldehyde as a probable human carcinogen; the NTP reasonably anticipates the chemical to be a human carcinogen; and, IARC classifies formaldehyde as a human carcinogen. Whether or not formaldehyde causes cancer in humans is unknown.

According to ATSDR, urban air contains more formaldehyde than rural areas; summertime outdoor air concentrations are higher than wintertime; and indoor air often contains higher amounts of formaldehyde than outdoor air (ATSDR, 1999; ATSDR, 2010). Although, some monitoring years indicate some higher concentrations between 2004 and 2010, overall the levels measured on Staten Island (ranging from 1.6 to 10.2 mcg/m<sup>3</sup>) are similar to those measured in urban atmospheres (California's annual-average in mid 1990s range from 4.32 to 6.62 mcg/m<sup>3</sup> and summer-time average in mid/late 1990s range from 0.2 to 63.67 mcg/m<sup>3</sup>) (ATSDR, 1999; ATSDR, 2010). Although the measured levels exceed DEC's AGC (0.45 mcg/m<sup>3</sup>), which is based on a one-in-one-million excess cancer risk for long-term exposure, the concentrations are estimated to pose a low risk of cancer over a lifetime.

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[https://www.atsdr.cdc.gov/toxprofiles/formaldehyde\\_addendum.pdf?id=1167&tid=39](https://www.atsdr.cdc.gov/toxprofiles/formaldehyde_addendum.pdf?id=1167&tid=39)

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USEPA, 1998. Acetaldehyde. Integrated Risk Information System. National Center on Environmental Assessment. Summary available at: [https://cfpub.epa.gov/ncea/iris/iris\\_documents/documents/subst/0290\\_summary.pdf](https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0290_summary.pdf)

## Appendix D – Comparisons of NATA modeled estimates with DEC monitor concentrations for air toxics data from Staten Island

The modeled concentration for the census tract in which the monitor was stationed was compared to the measured annual average for the five air pollutants. The median ratio across all monitoring stations and ratios for individual stations for Staten Island are shown in Tables 1 and 2, for NATA 2011 and 2014, respectively. As shown in Tables 1 and 2 the ratios are close to one, indicating good modeling agreement with the monitored concentrations. Modeling concentrations within a factor of two (ratios between 0.50 – 2.0) of measured concentrations are generally considered good. As shown, in Tables 1 and 2, the ratios are within this range and generally much closer to one for these five air pollutants, particularly for the 2014 NATA model. This analysis indicates that the modeled results can be used with confidence as surrogates for historical exposures.

**Table D1. NATA 2011 - Model-to-Monitor Comparisons**

Model-to-Monitor Ratios	1,3-Butadiene	Acetaldehyde	Benzene	Carbon Tetrachloride	Formaldehyde
Median result across all comparison	1.65	1.79	1.34	1.13	0.78
Staten Island – Residential	1.48	1.73	1.19	1.15	0.51
Staten Island – Source	1.83	1.33	1.15	1.12	0.78

**Table D2. NATA 2014 - Model-to-Monitor Comparisons**

Model-to-Monitor Ratios	1,3-Butadiene	Acetaldehyde	Benzene	Carbon Tetrachloride	Formaldehyde
Median result across all comparison	1.15	0.94	1.16	0.97	1.21
Staten Island – Source	1.61	0.79	0.99	0.98	1.10

## **Appendix E – Summary of industrial and inactive hazardous waste sites for Staten Island**

For additional information about any of these sites listed below, people can contact DOH staff at (518) 402-7860 or visit the DEC environmental site remediation database website at <https://www.dec.ny.gov/cfm/extentapps/derexternal/index.cfm?pageid=3> and enter the site code provided below.

### ***A & A Landfill (site code # 243011)***

This 40-acre site constitutes a landfill partly owned by A&A Land Development and Staten Island Arlington Inc (a subsidiary of CSX Transportation). Fill was dumped at this site to raise the grade. Fill materials were supposed to include soil, stones/rock, slag, concrete, and ash. In 1988, following allegations of hazardous waste dumping, fill operations were ceased and the operators of the landfill were convicted of fraud and racketeering charges in 1990. A site investigation found that asbestos, garbage and medical waste was dumped along with fill materials. This site did not qualify for listing on the Registry of Inactive Hazardous Disposal Sites. Management of this site has been assumed by DEC's Division of Materials Management.

### ***Arden Heights Shopping Mall (site code # 243007)***

According to testimony before the Senate Select Committee on Crime in May 1982, and before a State Supreme Court Jury in October 1982, this site was used for disposal of hazardous wastes. A small shopping mall has been built on the site, and is surrounded by wetlands on three sides. The site listing was based on allegations made at a Senate Select Committee hearing on crime dealing with hazardous waste dumping in New York City. Upon further investigation it was concluded that no hazardous waste disposal has been confirmed and the site does not qualify for addition to the Registry of Inactive hazardous waste disposal sites.

### ***Arden Woods Estates Inc. (site code #243010)***

In 1986 and 1987, buried drums were removed from the site. Contamination of soil and on-site groundwater by BTEX and naphthalene was found on-site. Although we have no information about past exposures to site contaminants, remedial actions, including soil removal, and additional control measures to prevent any potential exposures to any remaining contaminants are in place. The property has been re-developed.

### ***Arthur Kill Correction Facility (site code #C243039)***

A former firing range at the Arthur Kill correctional facility, which was used from 1979 to 2016, resulted in on-site lead-contaminated soils. Although remedial actions and measures are in place to mitigate potential exposures with on-site soils, there may have been some exposure to contaminated soils in the past if people contacted on-sites soils prior to control measures put in place.

### ***Allied Prince's Bay (site code #243014)***

This has been the site of a broad-ranging industrial activities since the 1800s until the 1970s.

Soil is known to be contaminated with lead, PCBs, PAHs, and volatile organic compounds. Currently, remedial actions have been completed and measures are in place to prevent people from contacting any residual contamination at the site.

***Ballpark at St. George Station (site code #V00228)***

The site was reportedly used as a railroad locomotive and railcar servicing and maintenance facility and railcar switchyard from 1883 to 1994. Prior to its development as a ballpark part of the property was used as a parking lot for the Staten Island Ferry. The New York City Economic Development Corporation (NYCEDC) purchased the site in November 1998 for the development of a minor league baseball stadium and parking facility. On-site soil was contaminated with arsenic and lead. Although past exposures to site-related contaminants were possible, remedial actions are complete and measures are in place to control the potential for coming in contact with residual contamination remaining at the site. Portions of the site is currently being redeveloped for the New York Wheel project and for the Empire Outlets Mall under an approved Site Management Plan.

***Brookfield Avenue Landfill (site code #243006)***

The Brookfield site was operated by the NYC Department of Sanitation (NYCDOS) from 1966 until 1980 as a disposal site for general refuse, including household garbage and construction wastes. Reports indicated that various hazardous wastes (i.e. waste oil, sludges, metal plating wastes, lacquers, and solvents) were illegally disposed from 1974-1980 at several NYC landfills, including Brookfield Avenue. Landfill operations resulted in contaminated soil and surface water contaminated with polychlorinated biphenyls, polycyclic aromatic hydrocarbons, pesticides, benzene, mercury, lead and other metals. Odors were also associated with the landfill operations. The landfill was closed and capped in 2010. Although we do not have any information about past site-related exposures, remedial actions are complete and measures are in place to control the potential for coming in contact with residual contamination remaining at the site.

***R. Baker & Son Machinery Dismantlers, Inc (Goethals Bridge Property) (site code #243008, 243037)***

Past activities at this site dating back to 1972, located under Goethals bridge, contaminated soil, sediments and/or groundwater with PCBs, 1,4-dichlorobenzene, chlorobenzene, 1,3-dichlorobenzene. Contamination is limited to the site and routine residential exposure is unlikely. Future plans to replace the Goethals bridge will be conducted in a manner that is protective of public health and will further limit exposures to any contaminants remaining at the site.

***Con Ed. Arthur Kill Station, Water Front (site code #243022)***

This is the site of active steam-generating station where PCBs contaminated the soil and sediments. Although past exposures to site-related contaminants were possible, remedial actions are complete and measures are in place to control the potential for coming in contact with residual contamination remaining at the site.

***Coral Island Shopping Center (site code #C243033)***

For more than 30 years, this shopping center held a dry-cleaning operation and chemicals associated with that operation (tetrachloroethylene, trichloroethene, cis-1,2-dichloroethene) contaminated the soil and groundwater. For this facility, remedial measures have been completed and measures are in place to control any potential exposures with residual contamination on site. An investigation of potential soil vapor intrusion into indoor air demonstrated that there were no actions needed to mitigate this exposure pathway. There are no off-site residential exposures.

***Former CJ's Service Center Property (site code #C243041)***

A gas station operated at this property from 1937 to 2014 and gasoline-related chemicals contaminated soil and groundwater. Specifically, benzene, toluene, xylenes, polycyclic aromatic hydrocarbons (PAHs) and methyl-*tert*-butyl ether (MTBE) are found on-site. People who enter the site could directly contact contaminated soil but the groundwater is not used for drinking water since the area is served by a public water system. Any future re-development on-site must include measures to prevent contaminated soil gas from entering buildings through a process called vapor intrusion. Off-site soil vapor intrusion investigation is needed.

***Former Nurses Building, Seaview Hospital (site code # C243034)***

This mostly vacant building located on Brielle Avenue has two occupants: a museum and a Shakespeare Theater. Known or suspected soil contaminants include volatile organic compounds, semi-volatile organic compounds, metals and polychlorinated biphenyls. In 2006, DEC denied a Brownfield Cleanup Program application to redevelop the building as elderly housing. Although soil samples indicate the existence of limited contamination, this contamination could be easily managed during construction-related management practices in order to prevent any human exposures. Soil vapor intrusion of volatile contaminants on-site into indoor air was a potential concern for the planned use of the redeveloped property.

***Former Port Mobile Terminal (site code #243016)***

Since approximately 1970, this 200-acre site held a petroleum bulk storage facility and gasoline related chemicals (benzene, toluene, ethylbenzene, xylenes) contaminated on-site soil and groundwater. Although we have no information about past exposure to site-related contaminants, currently there is no public access to the site and groundwater is not being used for public consumption.

***Fort Wadsworth – Battery Weed (site code #243015)***

This site has a long history of military use and soils are contaminated with PCBs. Remedial actions were completed in 1995 and measures are in place to prevent people from contacting any residual contamination at the site.

***Former Paul Miller Dry Cleaners (site code #243018, V00183)***

Dry cleaning operations occurred here from 1960 to present time, contaminating the soil, groundwater, soil vapor, and indoor air with dry cleaning chemicals (i.e., tetrachloroethylene and its breakdown products). Although past exposures to site-related chemicals were likely,

currently direct contact with chemicals in the soil is unlikely since most of the site is covered with buildings and pavement. Contaminated groundwater is not consumed by people as the area is served by public drinking water. Site investigations demonstrated that volatile chemicals in the underlying groundwater can enter on-site buildings and impact indoor air (vapor intrusion) resulting in potential past exposures. Because of these findings, a sub-slab depressurization system was installed to prevent chemicals in soil vapor from entering the building. Monitoring for soil vapor intrusion at several off-site structures is on-going.

***Charlton Cleaners (site code #243019, V00252)***

Dry cleaning operations at this location began in 1961 and onsite soils and groundwater were contaminated with the dry-cleaning chemical tetrachloroethylene. Over time, tetrachloroethene can break down in the environment to other volatile chlorinated chemicals. Direct contact with contaminants in the soil is unlikely because the site is covered with buildings and pavement. People are not drinking the contaminated groundwater because the area is served by a public water supply that is not affected by this contamination. These volatile chemicals can enter on-site buildings through a process called vapor intrusion. An investigation of the site identified impacts in the indoor air in the on-site building and a sub-slab depressurization system was installed to prevent vapors beneath the slab from entering the building. Monitoring for the potential for vapor intrusion at several off-site structures is on-going. Past exposures to site-related chemicals via inhalation of indoor air of on-site buildings were likely until the sub-slab depressurization systems were operational.

***Carol Cleaners, Staten Island Mall (site code #243020, V00318)***

A dry-cleaner operating at this location starting in the late 1960s contaminated on-site soil and groundwater with tetrachloroethylene (and its environmental degradation products). Contaminated groundwater at the site is not used for drinking or other purposes and the site is served by public water supply that obtains water from a different source not affected by this contamination. Volatile organic compounds in the groundwater may move into the soil vapor (air spaces within the soil), which in turn may move into overlying buildings and affect the indoor air quality.

***Great Kills Park***

Great Kills Park is currently part of the Gateway National Recreation Area and is operated by the National Park Service. In 2005, a radiation flyover for New York City identified an elevated radiation reading within the park. DOH worked with the Agency for Toxic Substances and Disease Registry (ATSDR) to assess potential radiation exposures based on use of these recreational facilities. In ATSDR's 2007 Health Consultation (available at: <https://www.atsdr.cdc.gov/HAC/pha/GatewayNatlRecreationArea/GatewayNationalRecAreaHC053107.pdf>), the agency calculated a maximum radiation dose of approximately 150 millirem/year from these sources, and recommended additional investigation because of the limited data available. Several additional recommendations were made to the US Environmental Protection Agency, National Park Service and City of New York and a public health action plan was enacted to restrict access to areas of detected contamination. National Park Service is currently undertaking a comprehensive remedial investigation to characterize



radioactive and potential chemical contaminants present within the Site. Once the entire Site has been thoroughly investigated, NPS will evaluate potential risks to human health and the environment; identify cleanup standards; evaluate alternatives to address environmental impacts; and recommend the implementation of a remedy that ensures the long-term protection of human health and the environment. Additional information can be found at <https://www.nps.gov/gate/learn/management/greatkillscleanup.htm>.

***Jewett White Lead (site code #243035)***

Lead processing took place on this site from 1839 to 1949. In 2010, DOH and the Agency for Toxic Substances and Disease Registry (ATSDR) concluded that long-term contact with residential soils contaminated with lead in the Port Richmond community could harm people's health and actions were recommended to prevent or reduce these exposures. The U.S. Environmental Protection Agency (USEPA) performed a removal action between October 2012 and February 2013 at the Jewett parcel bounded by Park Avenue, Richmond Terrace and the railroad tracks. The removal action included excavation and off-site disposal of soil contaminated with lead, backfilling the excavated area. More information is available online: <https://www.atsdr.cdc.gov/HAC/pha/JewettWhiteLeadProperty/JewettWhiteLeadPropertyLHC02-24-2010.pdf>.

***K - Clifton Manufactured Gas Plant (site code #243023)***

Beginning in 1850, this site was a manufactured gas plant where combustible materials such as coal, wood or oil would be heated in low-oxygen ovens to create a gas that could be stored and distributed to the surrounding area for lighting, cooking and heating homes. On-site soil was contaminated with BTEX, PAHs and lead. Although there may have been past exposures that we are unable to quantify, remedial activities were completed at the site and measures are in place to control any potential for coming in contact with any residual contamination at the site. Additionally, nearby residential yards were remediated for lead that may have been associated with the site.

***Mariners Marsh Park (site code #243036)***

Historic iron works, manufacturing and ship building at this site contaminated soils and groundwater with metals and PAHs. People who enter the site could contact contaminants in the soil by walking on the site, digging or otherwise disturbing the soil. People are not drinking the contaminated groundwater because the area is served by a public water supply that is not contaminated by the site. Additional investigation is needed to evaluate potential to come in contact with impacted soil and groundwater at the site. USEPA conducted a removal action to address grossly contaminated soil. On-going discussion with DEC and NYC to redevelop the property into useable green space. Currently overgrown parcel with trespassing.

***Narrows Metering and Regulating Facility (site code # V00513)***

This half-acre site holds a natural gas measuring and regulating station in a residential area in northeastern Staten Island. Past activities have resulted in a release of mercury onto site soils and there is a possibility of small amounts of polycyclic aromatic hydrocarbon and polychlorinated biphenyl contamination. The cause of the mercury release is thought to be

breakage and maintenance of pressure measuring devices known as manometers. The site has been owned and operated by the site owner as a natural gas metering facility for 49 years, and it is their intent to continue to operate it as such following remediation.

***Nassau Metals (site code #V00159)***

The site was used for industrial activities, including lead refining and copper smelting, which led to metals contamination of the soil and sediments at the site. Remedial actions and measures have been completed. Since some contaminated soils remain at the site below clean backfill, people will not come in contact with contaminated soils unless they dig below the surface. People are not expected to come into direct contact with contaminated groundwater because the area is served by a public water supply that is not affected by this contamination.

***Parcel 15 – Front Street (site code #243021)***

Soil and sediment at this property is contaminated with lead from past Naval and automotive repair activities. The primary contaminant of concern at this site was lead, in soil and groundwater, and on building surfaces. A removal action conducted at the site has removed all hazardous waste. Remedial actions were completed in 1996 and measures are in place to control for potential exposures with any residual contamination at the site.

***Pergament Mall / Corniche Dry Cleaners (site code #243012)***

Past (beginning in 1980) on-site dry-cleaner operations contaminated soil, groundwater and soil vapor with tetrachloroethylene and trichloroethene. Remedial actions are complete and measures are in place to control the potential for coming in contact with residual contamination remaining at the site.

***Port Ivory Site (Former Proctor & Gamble) (site codes #V00615, V00674, V00675)***

This 124-acre property is a former manufacturing facility for Proctor and Gamble (P&G) who operated from the early 1900's until 1991. The site contained numerous buildings used for the manufacture of consumer products including soap, detergent and foods. The Port Authority purchased the site from P&G in 2000. The Port Authority's planned use for this site includes an intermodal facility and container terminal for loading and unloading shipping cargo. On-site soils and groundwater are contaminated with PAHs and metals and solvents and/or petroleum products. Although DOH cannot rule out past exposures to contaminants on-site, remedial activities are complete and measures are in place to control the potential for contacting subsurface soil and groundwater contamination remaining on the site.

***Positive Chemical (site code #243001)***

This company packaged and recycled waste oil and chemicals. Soil and groundwater at this site is contaminated with gasoline-related chemicals (benzene, toluene, ethylbenzene, xylenes – collectively referred to as BTEX), isopropanol, aluminum sulfate, strontium acetate, strontium hydroxide, antimony, cobalt and polycyclic aromatic hydrocarbons. The US Environmental Protection Agency removed waste drums in 1990 and remedial actions have been completed. Measures are in place to control the potential for any contact with chemicals remaining on-site. We do not have any information about past exposures.

**2901 & 2945 Richmond Terrace (site code # V00251)**

This site is known as “The Storage Bin” and is located in a mixed industrial, commercial and residential area along the southern shoreline of the Kill Van Kull. The site was formerly occupied by First Marine Ship Yard, a marine terminal, consisting of 13 buildings which have been demolished. These buildings were used as mechanical shop, paint storage, plating shop, saw mill, warehouse and offices. A concrete mixing and molding facility, dry docks, an electrical transformer and other uses were identified also on site. The site is currently used for storage of concrete. Site activities included scraping, sand-blasting and repainting ships. Wetlands were also illegally filled. Soils and sediments are contaminated with petroleum products, semi-volatile organic compounds, and metals (lead, mercury, barium, arsenic, chromium and cadmium). Some contamination was also found in site groundwater. Based on the levels of contamination, however, the site did not qualify to be placed on the registry of inactive hazardous waste disposal sites.

**Staten Island Warehouse**

A number of buildings located at the site of the former Staten Island Warehouse located near the Bayonne Bridge in Port Richmond, New York, were used by Union Minière du Haut-Katanga Company to store high-grade Belgian Congo uranium ore from 1939 to 1942. In 1942, 2007 drums, containing 1089 metric tons of ore, were stored at the Staten Island Warehouse. Surveys performed by Oak Ridge National Laboratory in 1980 showed areas of elevated radioactivity; soil samples showed a 6cm layer of contamination (uranium and its decay products) located approximately 35-40 cm below the surface. A survey by the NYS Department of Environmental Conservation in 1992 showed similar results. After several denials (1985, 1992, 1994) the site was finally accepted into the Formerly Utilized Sites Remedial Action Program (FUSRAP). Site evaluation will occur at a later date pending the completion of currently ongoing cleanups at other FUSRAP sites and the availability of program funding. Additional information can be found at [https://www.lm.doe.gov/Considered\\_Sites/Staten\\_Island\\_Warehouse - NY 22.aspx](https://www.lm.doe.gov/Considered_Sites/Staten_Island_Warehouse_-_NY_22.aspx).

**Stucker’s Auto Yard (site code # 243027)**

In 1992, reports of a waste/used oil spill (spill # 9209904) initiated a hazardous waste investigation (completed in 1998). Site remedial activities were completed in 1999 and no additional hazardous waste was found at the site. The site did not qualify for addition to the Registry of Inactive Hazardous Disposal Sites.

**Sun Chemical Corporation (site code #C243024)**

From 1908 until 2008, industrial chemical manufacturing took place at this site located in the northeast portion of Staten Island. The site investigation is ongoing and the site has contaminated soil and groundwater. Contaminants found on-site in soils and groundwater include barium, cadmium, nickel, lead, arsenic, 1,1-dichloroethane, 1,1-dichloroethene, 1,1,1-trichloroethane, trichloroethene, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Currently, the site is vacant and fenced which restricts public access. The contaminated groundwater does not pose an exposure risk to nearby residents since households are served with public drinking water and investigations demonstrate that soil

vapor intrusion is not a concern for off-site buildings. On-site remediation of the site is complete. Additional investigation is needed to evaluate the potential for exposure to PCBs at one residential property adjacent to the site.

***Teleport, Staten Island (site code # 243009)***

This site is located near Goethals Bridge along the southeastern portion of the Staten Island Expressway. Approximately 20 old drums containing hazardous waste were discovered in a portion of the property where a teleport was proposed. The lot is currently owned by New York City and has been leased to the Port Authority of NY-NJ. All drums and contaminated soil were removed from the site and remedial measures have been completed.

***Vigliarolo Brothers (Onyx Chemical Company) (site code # 243005)***

From 1947 to 1963, this site located on Arthur Kill Road was used by Onyx Chemical for the manufacture of textile-processing materials and for the production of germicides and fungicides. Analytical results for sediments, soils and groundwater do not indicate that the site is a source of hazardous waste. Groundwater contamination of one well appears related to on-site vehicle maintenance. Allegations of drum disposal could not be substantiated. The site does not qualify for addition to the Registry of Inactive Hazardous Waste Disposal sites.

***Visy Paper (site code #V00015)***

The site is 35 acres in size and is comprised of two parcels consisting of abandoned Liquid Carbonic Property and a portion of Con Edison property. Both properties were contaminated with lime sludge, acetylene tanks, metals, PAHs, PCBs, dredged materials and petroleum products. All hazardous waste materials were excavated and shipped off-site for disposal. Property has been remediated and is being operated as a waste paper recycler. DOH has insufficient information to assess any potential human exposures to on-site contamination.