NEW YORK STATE | Department of Health

Governor's Cancer Research Initiative

Cancer Incidence Report for the Centereach/Farmingville/Selden Study Area

Albany, New York

August 2019

Executive Summary

This report summarizes an investigation of cancer patterns and trends and possible contributing factors in the Centereach, Farmingville, and Selden area of Suffolk County. 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. New York State Department of Health (DOH) researchers investigated this area of Long Island because of elevated numbers of lung, bladder, and thyroid cancers and leukemia.

During the Centereach/Farmingville/Selden Investigation, DOH obtained input from interested members of the community. Researchers met with community members to present the design, goals, and approaches of the investigation. 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

Sociodemographic Data

DOH researchers examined data about the population, such as race, ethnicity, age, education, income and occupational patterns, to see if these factors could be related to higher cancer rates. These data were obtained from the US Census.

Cancer Data

For each type of cancer that was elevated (lung, bladder, and thyroid cancers and leukemia), the evaluation of Cancer Registry data included cancer trends over time; age and gender of patients diagnosed with cancer; and characteristics of the cancer, such as type of cells that were cancerous, tumor size, and stage of disease at the time of diagnosis. Cancer data were obtained from the New York State Cancer Registry, which contains information on all cases of cancer diagnosed or treated in New York, as mandated by law.

Behavioral, Healthcare and Occupational Data

DOH researchers reviewed available data about behavioral, healthcare, and occupational factors in the community that are known to be related to cancer. These included available information about smoking, obesity, occupation, and medical care access and practices. Data sources included the Behavioral Risk Factor Surveillance System population survey, New York State inpatient and outpatient hospital discharge data, and the American Community Survey of the US Census.

Environmental Data

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, pesticides, and traffic density.

Findings

Sociodemographic Factors

Overall, the Centereach/Farmingville/Selden area had characteristics typical of Suffolk County, and more similar to New York State excluding New York City (NYS excluding NYC), than to the state as a whole (NYS including NYC). The study area, Suffolk County and NYS excluding NYC are less racially diverse than the state as a whole, with a greater percentage of people who are white. Educational levels, percent foreign born, and poverty status in the study area and Suffolk County are similar to those in NYS excluding NYC. The percentage of people in the study area and in Suffolk County who are Hispanic is similar to NYS and higher than in NYS excluding NYC.

Because the sociodemographics of the study area were more similar to those of NYS excluding NYC than to NYS, NYS excluding NYC was used as the comparison area in the analysis of cancer patterns and trends.

Cancer Patterns

Lung Cancer. Numbers of lung cancer cases were elevated for both men and women. Adults ages 65 and older accounted for most of the elevation. Lung cancer rates in this study area were also elevated before the timeframe of this investigation, although elevations were greatest in the 2011-2015 timeframe. The average percent of lung cancers diagnosed at an early stage in the study area was similar to that of NYS excluding NYC. Deaths from lung cancer were greater than expected in the study area, reflecting the high death rates associated with this cancer.

Smoking is the most important risk factor for lung cancer. The greatest percent elevations in the study area were observed for small cell lung cancer, the type most closely related to smoking, and adenocarcinoma, the type that is least strongly related to smoking. Most of the people with lung cancer in the study area had a history of smoking at some time in their lives, and the proportion who had never smoked was smallest for the types most closely associated with smoking.

Bladder Cancer. Bladder cancer was elevated in both men and women in the study area. Older men accounted for most of the excess. Bladder cancer rates in the study area were higher compared to Suffolk County and NYS excluding NYC in 2011-2015 but not in the previous time period, 2005-2009. Most bladder cancer cases in the study area and in the comparison area were of the papillary cell type.

Thyroid Cancer. Thyroid cancer was elevated in both men and women in the study area, although the percent elevation was greater in men. Numbers of cases were greater than expected in almost all age groups, with the greatest elevations found in young adults, ages 20-49, and adults ages 65 and older. Thyroid cancer incidence in the study area was higher than that in Suffolk County, which itself had incidence higher than in the rest of the state, in both 2011-2015 and in 2005-2009. Most of the excess in 2011-2015 was in the papillary type of thyroid cancer, which accounted for most of the cases, and in tumors that measured 2 centimeters or less. The number of deaths from thyroid cancer was not elevated, but deaths from this cancer are rare.

Leukemia. Most of the excesses in leukemia in the study area were among children who had been diagnosed with acute lymphocytic leukemia (ALL), and adults aged 65 and older who had been diagnosed with chronic lymphocytic leukemia (CLL) and chronic myelogenous leukemia (CML). The excess was not present in the previous time period, 2005-2009, and numbers of cases increased over time. The number of deaths from leukemia in the study area was not elevated.

The excess in childhood leukemia occurred in both boys and girls but was only statistically significant in boys. About half of the children with leukemia were diagnosed in 2015. None of the children with leukemia lived in proximity to each other.

Reporting of cancer cases by health care providers other than hospitals is especially important for cancers for which patients are not always hospitalized, such as chronic leukemias. In the study area and in Suffolk County, there was a greater proportion of chronic leukemia cases reported by independent laboratories compared to NYS excluding NYC.

Behavioral, Healthcare System, and Occupational Factors

Tobacco Use. Lung and bladder cancer are both tobacco-related. Behavioral surveillance data suggested that people age 18 years and older in the study area were more likely to smoke, although the sample size was limited. A review of hospital discharge data indicated that a slightly higher proportion of people in the Centereach/Farmingville/Selden area had records with billing codes related to smoking compared to Suffolk County and NYS excluding NYC. The rate was most elevated in people aged 65 and older.

Obesity. An increased risk of thyroid cancer is modestly associated with obesity. Behavioral surveillance data suggested that the percent of people aged 18 and older in the study area who are obese is greater than in the other areas, although the sample size was limited. A review of hospital discharge data indicated that a slightly higher proportion of people in the Centereach/Farmingville/Selden area had records with billing codes related to obesity compared to Suffolk County and NYS excluding NYC. The differences were greatest in people over age 50.

Healthcare System. The healthcare system itself can influence the likelihood that someone could be diagnosed with certain cancers, such as thyroid cancer or chronic leukemias, before any symptoms appear. People with health coverage can more easily access healthcare services. Behavioral surveillance data suggested that a greater percentage of Centereach/Farmingville/Selden area residents aged 18-64 had health coverage compared to Suffolk County and NYS excluding NYC, although sample size was limited.

Occupation. Lung and bladder cancers and certain types of leukemia have been associated with various workplace exposures. U.S. Census data on employed persons 16 years and older showed that the study area had a slightly greater percentage of people working in occupations with a higher probability of workplace exposures to elevated levels of hazardous substances compared to persons in NYS exclusive of NYC and NYS as a whole. These occupations included production, construction, installation, maintenance and repair, transportation and firefighting.

Community members and medical professionals reported that many first responders to the World Trade Center attacks in NYC on September 11, 2001 lived in the Centereach/Farmingville/Selden study area. The U.S. Census indicated a slightly higher percentage of people in the study area were firefighters and law enforcement personnel compared to other areas of the state, but these estimates were based on small numbers. The nearby Stony Brook University Hospital conducts medical monitoring of World Trade Center rescue and recovery workers. Researchers reviewed available studies of three groups of World Trade Center rescue and recovery workers. These populations were 81-100% men. The studies showed that World Trade Center rescue and recovery workers had an elevated rate of thyroid cancer, with numbers of cases two to three times those expected. The higher incidence of thyroid cancers in the period directly after the attacks was believed to be due to the enhanced medical surveillance that these workers received.

Environmental Factors

Outdoor Air Pollution. Researchers reviewed air quality monitoring and computer modeled data for air pollutants and air toxics. The available data suggest that people living in the Centereach/Farmingville/Selden study area are not exposed to unusual levels of air pollution and the overall cancer risk associated with air pollution levels is low.

Radon in Indoor Air. Radon is the second leading cause of lung cancer after smoking. Researchers evaluated radon testing frequency and compared average concentrations in the Centereach/Farmingville/Selden area to EPA's recommended action level, as well as other areas of the state. This evaluation showed that radon is not a significant environmental exposure in the study area and that radon tests were generally lower than those for NYS, NYS excluding NYC and Suffolk County.

Drinking Water Quality. Researchers reviewed public drinking water data to identify potential drinking water exposures. The study area is served by the Suffolk County Water Authority, which services all of Suffolk County through a network of groundwater wells. The review showed no exceedances of drinking water standards in the public water supply system for cancer-related contaminants during the time period that data were available. Review of available data for unregulated contaminants, based on the United States Environmental Protection Agency's (EPA) unregulated contaminant monitoring rule program, showed that the public water delivered within the study area had levels below EPA reference concentrations.

Industrial and Inactive Hazardous Waste Disposal Sites. Researchers reviewed information about existing sites in the Centereach/Farmingville/Selden study area. Local residents also raised concerns about the Northville pipeline, which runs through the study area, and about a gasoline spill at the Northville Terminal in East Setauket. The existing information did not suggest that any contamination from the Northville pipeline, the gas spill at the Northville Terminal or any other sites is causing widespread exposures in the study area.

Pesticides. DOH researchers reviewed the available data on commercial pesticide applications to assess whether unusual patterns exist in the Centereach/Farmingville/Selden study area. Commercial pesticide use in the ZIP Codes of the study area was compared to an area of Suffolk County running from the eastern border of the Town of Brookhaven west to the Nassau County border. The evaluation showed that commercial pesticide applications in ZIP Codes corresponding to the study area were smaller in quantity per square mile and per household than in the comparison area. Almost all of the ingredients applied were in products used to keep lawns green and free from weeds and insects.

Traffic. Researchers evaluated the impacts of traffic as part of the outdoor air and emissions data evaluation described above. Researchers also reviewed available data about how impacts of traffic pollution compare with other areas of NYS. In general, the Centereach, Farmingville, Selden had a similar percentage of people living near roadways as NYS excluding NYC.

Discussion

Lung Cancer

Although lung cancer rates have declined in recent years, lung cancer remains the leading cause of death from cancer for both men and women in the U.S. Cigarette smoking is still the most important cause of lung cancer, accounting for 80 to 90 percent of all cases. Exposure to radon, a naturally occurring colorless, odorless gas, is the most important environmental risk factor for lung cancer. Other important risk factors include secondhand smoke, radiation to the chest from medical procedures, family history, some air pollutants, and possibly diet. Workplace exposures to asbestos and arsenic, as well as chloromethyl ethers, beryllium, chromium, cadmium, nickel, silica, diesel exhaust, and soot, are also associated with lung cancer.

Data suggest that people living in the study area were more likely to use tobacco than people in the comparison areas. The study area had slightly higher percentages of people working in occupations where workplace exposures linked to lung cancer were more likely, although data were insufficient to evaluate possible exposures. Results of radon testing in area homes indicate that concentrations are lower than in comparison areas. Results from the environmental data review did not show any environmental exposures that could explain the elevated incidence of lung cancer in the study area.

Bladder Cancer

The most important risk factor for bladder cancer is smoking. It is estimated that smoking is responsible for up to 50% of all bladder cancer cases. Workplace exposures are also important in bladder cancer and may account for as many as 20% of cases. Elevated risks have been found among rubber, plastic, dye, and metal workers, hairdressers, painters, and bus and truck drivers. Specific substances linked to bladder cancer in these occupations include aromatic amines (used in dyes), diesel exhaust, and polycyclic aromatic hydrocarbons (formed during the incomplete burning of coal, oil, gas, wood, or other organic substances). Bladder cancer has been associated with exposures to high levels of arsenic in the drinking water, and there is some evidence that it may be related to consumption of water disinfection byproducts (trihalomethanes).

Data suggest that people living in the study area were more likely to use tobacco than people in the comparison areas. The study area had slightly higher percentages of people working in occupations where workplace exposures were more likely compared to NYS excluding NYC and Suffolk County, although data were insufficient to evaluate possible exposures. A review of drinking water testing data in the study area showed no evidence that exposures to contaminants in drinking water that have been linked to bladder cancer contributed to the elevated incidence of this cancer. Results from the environmental data review did not show any environmental exposures that could explain the elevated incidence of bladder cancer in the study area.

Thyroid Cancer

Many recent articles in the scientific literature have concluded that the primary risk factor for thyroid cancer is medical system practices. These include diagnostic imaging with a neck ultrasound, or another form of imaging in the absence of symptoms. It has been estimated that 70-80% of female thyroid cancer cases and 45% of male thyroid cancer cases diagnosed in the U.S. fall into this category. Other risk factors for thyroid cancer include exposure to ionizing radiation such as radiation treatments for a previous condition, a family history of the disease, and certain hereditary conditions. Obesity has been associated with a relatively small increased risk of thyroid cancer.

The elevations in papillary tumors and tumors less than 2 centimeters in the study area are consistent with national trends. Papillary carcinomas are slow growing and rarely fatal. While larger tumors might be found as a noticeable lump that would cause a patient to seek medical care, smaller tumors may not produce any symptoms and may only be detectable by medical techniques. The finding that a greater proportion of study area residents may have health care coverage suggests that they would have greater opportunity to have medical imagery and other examinations performed. There may also be differences in contact with the healthcare system in people with coverage, and in local practices of medical imaging, use of sensitive diagnostic techniques, and clinical examination.

Rescue and recovery workers at the World Trade Center site have an elevated rate of thyroid cancer, and the location of medical monitoring services in a nearby community suggests that many of these workers may live in the study area. The greater elevation of thyroid cancer in men than in women in the study area is also consistent with a contribution by World Trade Center workers. The probability of any one worker being diagnosed with thyroid cancer in a five-year period, even at an elevated rate, however, is small, and any World Trade Center first responders living in the area would likely have had a very small influence on the overall higher rates of thyroid cancer.

Data indicate that a greater proportion of people in the study area were obese compared to Suffolk County and NYS excluding NYC. Since the differences in percent obese were only of moderate size and obesity is only associated with a small increased risk of thyroid cancer, this would only have a very small influence on the higher rates of thyroid cancer in the area.

Results from the environmental investigation did not show any unusual environmental exposures that could explain the elevated incidence of thyroid cancer in the study area.

Leukemia

There are four major types of leukemia, distinguished by how quickly the disease progresses (acute vs. chronic), and the type or types of blood cells affected. Acute lymphocytic leukemia (ALL), the most frequently diagnosed type in children, has been associated with certain genetic syndromes such as Down syndrome and exposure to ionizing radiation. Parental exposures and conditions around the time of birth may be important in children, and numerous occupational exposures have been investigated in adults. Acute myelogenous leukemia (AML) is the second most frequently diagnosed type of leukemia in adults, but also affects children and adolescents. Established risk factors include genetic syndromes such as Down syndrome, exposure to ionizing radiation, several drugs used in chemotherapy, occupational exposures to benzene and possibly other chemicals, and smoking. Chronic lymphocytic leukemia (CLL) is the most frequently diagnosed type of leukemia in adults, but rarely occurs in children. The only well-established risk factor for CLL is a family history of the disease. Chronic myelogenous leukemia (CML) occurs mostly in older adults but can affect children and adolescents. Exposure to ionizing radiation is a risk factor, and it may also be related to smoking, certain types of chemotherapy and possibly certain occupational exposures.

Even after intensive investigation, the causes of many reported clusters of childhood cancers remain unknown. These occurrences are often limited in time. Since about half of the cases in the study area occurred in the last year of the time period studied, it is not known whether the increased incidence has continued.

The elevated number of cases of chronic leukemias, especially among older adults, could be due to greater reporting by independent clinical laboratories in the study area. A higher percentage of people with healthcare coverage may also indicate that people in the study area may have greater contact with the health care system and may be more likely to have routine testing that would identify this cancer.

Results from the environmental investigation did not show any unusual environmental exposures that could explain the elevated incidence of leukemia in the study area.

Conclusions

- It is likely that higher rates of current and former tobacco use contributed to the elevated rates of lung and bladder cancer in the Centereach/Farmingville/Selden area.
- Available information did not indicate any particular occupation or workplace that may have played a role in the cancer elevations, although the scientific literature does indicate that exposures to hazardous substances in the workplace can be important for lung and bladder cancers and some types of leukemia.
- Most of the increased incidence of thyroid cancer seen nationally in recent years is likely due to the increased detection of small papillary tumors by medical imaging and other diagnostic techniques, and this likely played a major role in the Centereach/Farmingville/Selden area. Increased surveillance would account for elevated diagnoses of thyroid cancers among people who had spent time in rescue and recovery efforts at the World Trade Center site, although the contribution of these people to the overall excess would likely be small. An increased prevalence of obesity in the area could have also made a small contribution to the increased incidence of thyroid cancer.
- The investigation uncovered no factors that might account for the elevated number of childhood leukemias. Since about half of the cases occurred in the last year of the time period studied, the DOH will continue to monitor the incidence of childhood leukemia in the Centereach/Farmingville/Selden area.
- The elevated number of cases of chronic leukemias, especially among adults 65 years and older, might be related to greater cancer reporting by independent laboratories in the area. It might also be related to medical care factors such as healthcare coverage or greater contact with the health care system.
- Environmental factors evaluated in this study, including radon concentrations in indoor air, environmental contaminants in outdoor air and in drinking water, industrial and inactive hazardous waste disposal sites, pesticides, and traffic density, show no unusual environmental exposures that could explain the elevated incidence of certain cancers in the study area.

Recommendations

The recommendations below are divided into two main sections: 1) recommended actions to address the specific cancers that were elevated in the Centereach/Farmingville/Selden 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 Specific Cancers Elevated in the Centereach/Farmingville/Selden Study Area

Health Promotion and Cancer Prevention

Tobacco Prevention

Recommendation: Prevent initiation of tobacco use, including combustible tobacco and electronic vaping products, by youth and young adults.

Recommendation: Promote tobacco use cessation, especially among populations disproportionately affected by tobacco use including: low socioeconomic status; frequent mental distress/substance use disorder; lesbian, gay, bisexual and transgender; and disability.

Recommendation: Eliminate exposure to secondhand smoke and exposure to secondhand aerosol/emissions from electronic vapor products.

Healthy Nutrition and Physical Activity

Recommendation: Promote healthy eating and food security by:

- Increasing access to healthy and affordable foods and beverages,
- Increasing skills and knowledge to support healthy food and beverage choices,
- Increasing food security, and
- Increasing awareness of DOH sportfish advisories to promote healthier fish consumption choices while reducing chemical exposures (https://www.health.ny.gov/environmental/outdoors/fish/health_advisories/).

Recommendation: Increase physical activity by:

- Improving community environments that support active transportation and recreational physical activity for people of all ages and abilities,
- Promoting school, child care, and worksite environments that support physical activity for people of all ages and abilities, and
- Increasing access, for people of all ages and abilities, to safe indoor and/or outdoor places for physical activity.

Cancer Screening and Early Detection

Lung Cancer Screening

Recommendation: Educate men and women who meet the criteria for lung cancer screening about the benefits and risks of screening to help them make informed decisions.

Recommendation: Healthcare providers need tools and support to engage with patients who may benefit from screening, and facilities adopting lung cancer screening programs should be following national guidelines for a quality program.

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.

Healthy and Safe Environment

Radon Testing and Mitigation

Recommendation: Improve the public's awareness about the relationship between indoor radon exposure and lung cancer by conducting outreach and education about building testing and remediation. Promote the DOH's free and low-cost radon test kit programs, provision of test kits at half price to schools and daycares, and free test kits as part of the DOH's Healthy Neighborhoods Program and other grant-funded programs.

Recommendation: Explore local level policy and/or code adoption to require radon resistant construction in high radon areas.

Recommendation: Increase the number of health care providers that ask their patients if they have had their homes tested for radon and refer them to the DOH, as needed. Add radon testing questions to routine electronic medical questionnaires.

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.

Safety in the Workplace

Recommendation: Develop targeted occupational safety and health training programs for employers and workers in high-risk jobs.

Recommendation: Incorporate industry and occupation into electronic health records and other patient-oriented databases.

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.

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, 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/.

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/.

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For questions and comments please send an email to canmap@health.ny.gov.

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Introduction

About 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 time in their lives[1]. 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 and reported 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 in some areas of New York State based on a review of available data sources.

Selection of Study Area and Types of Cancers Being Studied

The Long Island study area, including the communities of Centereach, Farmingville and Selden in Suffolk County, was chosen as a result of review of data and statistical analyses performed in the development of the DOH Environmental Facilities and Cancer Mapping application tool, which is available online at https://www.health.ny.gov/statistics/cancer/environmental_facilities/mapping/. The maps show counts of total cancers and of 23 types of cancer newly diagnosed from 2011 through 2015 by census block group in New York State. The maps also identify areas where the incidence of cancer was higher or lower than expected. To identify areas of higher or lower than expected cancer incidence, researchers calculated the expected incidence of each cancer type. Expected cancer incidence was calculated using cancer rates for NYS as a whole applied to the population of an area, taking into account that area's age and sex distribution. This shows the number of cases that would occur in the area if the people there developed cancer at the same rate as people in all of New York State. Highlighted areas are those where the observed cancer incidence differed from the expected cancer incidence by more than 50%, and the difference was not likely to be due to chance. The Centereach/Farmingville/Selden (CFS) study area is the geographic area where areas with higher than expected incidence for four different types of cancer for the years 2011-2015 overlap: lung cancer, bladder cancer, thyroid cancer and leukemia.

Approach

The following sections provide an overview of the approach taken to evaluate cancer incidence in the CFS study area. A number of data sources were evaluated and analyzed to gather information for this report. A summary of those data sources can be found in Appendix 1.

> **What is the expected number of cases?**
> The expected number of cancer cases is the number of cases of cancer one would expect to find, if cancer rates in the study area were the same as in similar areas of the state. The expected number of cases is calculated by applying cancer incidence rates, by age and sex, for a reference area, to the estimated population of the study area, also by age and sex.
>
> **What are cancer subtypes?**
> Subtypes are smaller groups that a cancer can be divided into, based on certain characteristics of the cancer cells, such as how the cancer cells look under a micro-scope, and whether there are certain substances in or on the cells or certain changes to the DNA of the cells.
>
> **What is summary stage?**
> **Summary Staging** is the most basic way of categorizing how far a cancer has spread from its point of origin. In the simplest form it has three categories: localized, regional, and distant.
> A **localized** cancer is limited to the organ of origin; it has spread no farther than the organ in which it started.
> At **regional** stage, the cancer has extended beyond the limits of the organ of origin. This can be either through spread into adjacent organs or surrounding tissue, or spread into nearby lymph nodes, or both.
> At **distant** stage, the cancer has spread beyond adjacent organs/tissues or nearby lymph nodes. Most commonly this involves distant metastases, that is, tumor cells have broken away from the original tumor, have travelled to other parts of the body, and have begun to grow in the new location.

Evaluation of Cancer Patterns

To gain insight into possible factors that may be contributing to the elevated incidence of the four cancers in the CFS study area, we first reviewed information from the New York State Cancer Registry to take a closer look at the cancers that were identified. Since different cancers are different diseases, with different sets of risk factors and causes, analyses of the cancer data were done separately for each of the four cancers. The separate analyses involved factors that may be important for understanding the occurrence of the cancer, taking into account its specific risk factors.

The statistical analysis on which the maps were based showed that the total numbers of cases of the four cancers were greater than the total numbers expected. However, it is possible that, for example, the excess was concentrated in one age group or involved only one or a few subtypes of that cancer. A closer examination of patterns in the diagnosed cancers can often provide valuable clues as to what might be involved in their causation.

In the review of cancer data, the occurrence, or incidence, of the cancers was examined for different age groups for males and females separately. We also reviewed the incidence of different cancer subtypes or cell types, the proportions of cancers diagnosed at different summary stages and, where applicable, different sizes. Variation of the incidence of the four cancers over time was also examined. All of these analyses were conducted based on information contained in the New York State Cancer Registry (see Data Sources for a description of the Cancer Registry).

Following the review of data on cancer incidence, we next examined data on cancer mortality, or deaths from cancer. Cancer mortality can be a measure of the impact of the cancer on a community. Cancer mortality is influenced by the effectiveness of treatment and the severity of the cancers that occur. To measure cancer mortality in the study area, we identified all people listed in the Cancer Registry who had died from a given cancer while they were living in the study area. Numbers were compared with the numbers that would be expected based on similarly computed rates for the comparison area. People are listed in the Cancer Registry if they were diagnosed with or treated for cancer while living in New York or if they were diagnosed with or treated for cancer at a health care facility in New York. Cancer Registry files do not include the (likely small) number of people who were known to be diagnosed and treated at out-of-state facilities while living out of state but later moved to and died in New York. Since deaths were identified the same way in the study area and in the comparison population, any undercounts of people dying from cancer should be of similar size in the study and comparison areas.

Statistical methods in these reviews were largely based on computing observed and expected numbers of cancers in different categories, for example individual age and sex groups or tumor histologies. Statistical testing was used to evaluate whether any differences between observed and expected numbers of cases were likely to be due to chance. Results not likely to be due to chance were designated "statistically significant." Confidence intervals were also calculated around the ratio of observed to expected numbers of cases and other statistical measures such as rates and the prevalence of various behaviors as assessed by survey. When not provided in

What is statistical testing?
Statistical testing is used to determine the probability that the findings obtained could have occurred by chance. In the evaluations of observed and expected numbers of cancer cases, findings are compared with tables of the Poisson distribution, which describes a process where a rare event occurs in a large population. If the probability of observing an excess or deficit is 0.025 or less, the result was considered to be statistically significant. Non-significant excesses or deficits are considered to represent random variations in observed patterns of disease.

What are confidence intervals? Confidence intervals are indicators of the stability of a statistical estimate, with wider intervals indicating a less stable estimate. When applied to the ratio of observed to expected numbers of cases, confidence intervals that do not include the value 1.0 indicate that the observed number of cases is statistically different from the expected number.

the text, confidence intervals are shown in the appendix tables.

Further review of the cancer data was based on what was found in the initial reviews and what is known about the particular cancers. Efforts included the examination of other data contained in the Cancer Registry pertaining to such factors as a prior history of cancer, the diagnosis and reporting of the cancer and other factors related to medical care.

Evaluation of Sociodemographic, Behavioral, and Healthcare Factors

Although cancer risk factors operate at the individual level, the proportion of people who have a given risk factor may vary from place to place. This can lead to differences in the incidence of various cancers. For example, lung cancer rates would be expected to be higher in a community where many people smoked or were former smokers than in a community where few people had ever smoked. Cancer risk factors include sociodemographic characteristics such as age, race/ethnicity, income and education; health risk behaviors such as smoking and diet; and factors related to the health care system, such as access to medical care and local practices of diagnosing various diseases and conditions.

The Environmental Facilities and Cancer Mapping application accounted for age and gender in the analyses that identified the CFS study area. However, differences between the study area population and the population of New York State on other variables could help to explain why the Environmental Facilities and Cancer Mapping analysis showed a higher-than-expected incidence. Therefore, distributions of other sociodemographic factors, such as race/ethnicity and socioeconomic status, were explored further. Staff reviewed available data from the US Census and the American Community Survey to better understand community characteristics and how these characteristics may inform interpretations about cancer incidence in the CFS study area. More details about US Census and the ACS can be found in Appendix 1 and at https://www.census.gov/.

Currently, data related to individual-level health risk behaviors are generally reported at the county level, since the sample size needs to be large enough to provide a stable and reliable estimate. This is problematic in the current evaluation, since the CFS study area is only one small part of Suffolk County. Information on larger geographic areas (e.g., Suffolk County) can mask substantial variations in smaller areas (e.g., the CFS study area) that may be relevant to public health.

There are few data products available that provide subcounty-level estimates for indicators relevant to this study, such as the prevalence of smoking or obesity or the proportion of the population that has access to health care. Therefore, as part of this evaluation, subcounty estimates of health risk behaviors were sought to better understand possible reasons for higher-than-expected incidence. For the two data sources outlined below, staff assessed the results and evaluated the degree of consistency between them.

Expanded Behavioral Risk Factor Surveillance System (BFRSS) Analysis. The Behavioral Risk Factor Surveillance System (BRFSS) is an annual survey that gathers information on health risk behaviors. In addition to questions about tobacco use, physical inactivity, diet, use of cancer screening services, and other factors linked to the leading causes of morbidity and mortality, the BRFSS contains a question on whether the respondent has health care coverage, such as health insurance, an HMO, or government plans. More details on the BRFSS can be found in Appendix 1. During two recent survey cycles, 2013-2014 and 2016, DOH conducted an expanded BRFSS (eBRFSS) which increased the overall survey sample size to provide representative estimates on the county level. Although the eBRFSS was not specifically designed to produce subcounty estimates, BRFSS staff did a special analysis to derive combined prevalence estimates for the three ZIP Codes that approximate the CFS study area (see Figure 1.). More details on the eBRFSS and the analysis used in this study may be found in Appendix 1.

NYS Statewide Planning and Research Cooperative System (SPARCS) Analysis. A second approach used the DOH Statewide Planning and Research Cooperative System (SPARCS) for information about hospitalizations and emergency department (ED) admissions to provide insight into the burden of health risk behaviors in the study area. For this analysis, staff determined whether the residences of people who visited the hospital were either in the study area or in a comparison area. Next, each record was searched for codes related to the health risk behavior of interest. Summary measures were calculated based on the proportion of people who received a hospital service and had a code indicating a health risk behavior divided either by the total number of people who received a hospital service or by the population living in the study area. The numbers in the tables produced by this analysis should not be interpreted as rates for a particular health risk behavior, but as an indicator of the burden associated with that indicator for the specific population of interest. For this analysis, staff reviewed records with codes related to tobacco use and obesity, important modifiable risk factors associated with cancer incidence.

Environmental Data Review

Overview

To assess whether residents of the CFS study area have a history of unusual environmental hazards and potential exposures in comparison to New York State excluding New York City and/or New York State as a whole, extensive reviews of available data were conducted by staff from the New York State Department of Health (DOH) and the New York State Department of Environmental Conservation (DEC). These evaluations focused on 1) outdoor air quality, 2) radon in indoor air, 3) drinking water quality and 4) remedial sites in the study area. DOH also explored specific environmental concerns raised by community members, such as pesticide use.

Outdoor Air Quality

Federal and state air pollution control programs have at their disposal 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 in the CFS study area as well as in New York State more generally:

1. The US Environmental Protection Agency's (EPA's) Air Quality System database; and
2. EPA's National-scale Air Toxics Assessment (NATA) data.

The EPA's **Air Quality System** database contains data from air quality monitoring stations across New York State at various locations and timeframes since 1965. This database currently includes sulfur dioxide, ozone, carbon monoxide, nitrogen dioxide, lead, total suspended particulates, and particulate matter less than 2.5 and 10 microns (PM2.5 & PM10) 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.

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. For the NATA program**,** EPA estimates chemical-specific air concentrations for small geographic areas known as census tracts across the US (https://www.epa.gov/national-air-toxics-assessment). Additional information about these data sources can be found in Appendix 1.

Radon in Indoor Air

Radon data from indoor air tests conducted from 1987 to 2015 were used to estimate various measures for the CFS study area, New York State excluding New York City, and New York State as a whole. The summary measures of radon test results include total number of tests conducted, average and maximum test values, percent of tests that were at or above the action level of 4 pCi/L, and number of tests and average radon concentrations 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 concentrations by census block group. See Appendix 1 for more information about the data sources evaluated.

Drinking Water Quality

This review evaluated drinking water data associated with required routine sampling conducted by 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 EPA. 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 most regulated analytes, Maximum Contaminant Levels (MCLs) have been established (lead and copper have similar regulatory limits called action levels). A violation of a standard occurs when the established MCL is exceeded and confirmed with a follow-up sample. 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 the MCL would trigger a violation.

This review evaluated sampling data for finished water for community water systems at entry points to the distribution system. Staff reviewed exceedances and violations. In cases where violations were issued, information about the violations is provided. Private wells are not subject to federal or state regulations, so complete data for all private wells are not available. However, available data from private well tests were also reviewed. See Appendix 1 for more information about the data sources evaluated.

Industrial and Inactive Hazardous Waste Disposal Sites

DOH and DEC staff developed an inventory of inactive hazardous waste sites and brownfield sites for the CFS study region. Area residents who participated in public meetings also identified sites of concern. DOH staff evaluated the available information to determine whether people may have been exposed to any contaminants released from these sites. More information on the review of remedial sites can be found in Appendix 1.

Pesticides

DOH researchers used the available data on commercial pesticide applications to assess whether any unusual patterns exist in the CFS study area. The New York State Pesticide Reporting Law, enacted in 1996, requires that commercial applicators maintain a record of each pesticide application made.

For this evaluation, pesticide application data at the ZIP Code level were downloaded for the years 2000 through 2013. US EPA's Pesticide Product Information System (PPIS) was also referenced to the Pesticide Sales and Use Reporting (PSUR) data to evaluate the active ingredients contained in each of the products. More information about the evaluation of pesticide applications may be found in Appendix 1.

Other Concerns - Traffic

Members of the community also had concerns about impacts of traffic pollution in the study area. It bears noting that 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 is processed 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.

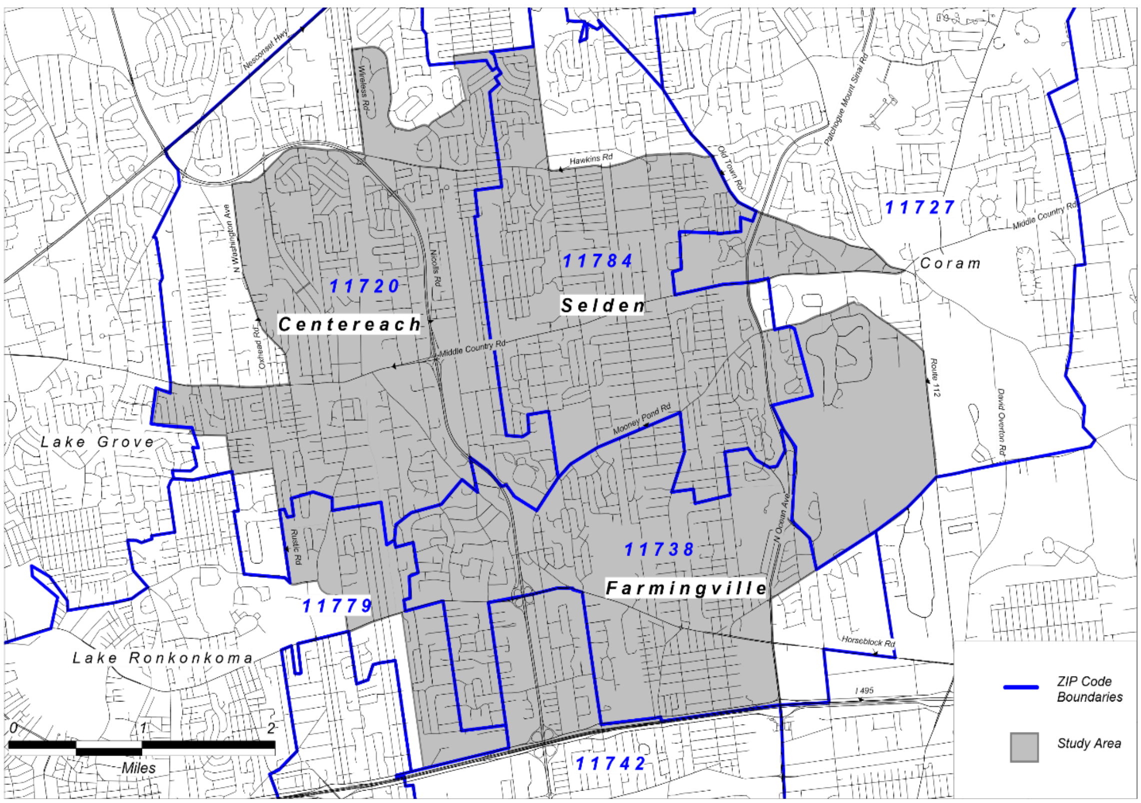
Findings

Study Setting and Initial Findings

Description of Study Area

The Centereach/Farmingville/Selden study area consists of 39 Census block groups in western Brookhaven Town, Suffolk County (Figure 1). These 39 block groups comprise 11 entire census tracts, plus portions of four others. (A listing of the specific census tracts and block groups included in the study area may be found in Appendix 2, Table 1a.) The average estimated population of the area in the period 2011-2015 was approximately 64,615 persons.

Figure 1. Centereach/Farmingville/Selden study area, Town of Brookhaven, Suffolk County



This is a largely suburban residential community. It is bounded on the south by the Long Island Expressway, and a few commercial thoroughfares run through it. The Ammerman campus of Suffolk County Community College is located near the center, and Brookhaven Town Hall is located in the hamlet of Farmingville.

Like much of Long Island, the area was originally farmland. Aerial photographs from the 1920s show the area was largely farmland or undeveloped at that time. Suburban development began after World War II, with many housing developments apparent by 1962. Housing developments became more numerous after the construction of the Long Island Expressway, and housing units and population continued to increase until the present. Beginning in the 1970s, businesses became evident along the major thoroughfares, and some industrial properties appeared.

Demographic and Socioeconomic Characteristics

The incidence of many cancers varies for different racial and ethnic groups, and among areas with different socioeconomic characteristics, such as education and income. Selected demographic and socioeconomic characteristics of the Centereach/Farmingville/Selden study area are highlighted in Table 1 below. (The table includes data for the 11 census tracts completely in the study area, and the four tracts for which only certain block groups are in the study area.) The table also compares the study area with New York State as a whole, New York State excluding New York City, and Suffolk County. More detailed characteristics, including breakdowns by individual census tracts in the study area, can be found in Appendix 2, Tables 1b and 1c.

Table 1. Key demographic and socioeconomic characteristics, Centereach/Farmingville/Selden study area compared with New York State, New York State excluding New York City, and Suffolk County

Characteristics	NYS	NYS excl. NYC	Suffolk County	CFS study area*
	Percent	Percent	Percent	Percent
Race				
White alone	64.58	80.53	80.95	87.40
Black alone	15.61	8.93	7.66	4.47
Am. Indian, Alaskan Native alone	0.38	0.37	0.21	0.36
Asian alone	7.98	3.83	3.78	4.05
Other race alone	8.60	3.73	4.98	2.13
Two or more races	2.85	2.61	2.42	1.60
Ethnicity				
Hispanic	18.40	10.51	17.81	15.71
Non-Hispanic	81.60	89.49	82.19	84.29
High School/College Diploma, age 25+	85.63	89.65	89.93	91.51
Foreign Born	22.48	11.42	15.14	12.31
Above Poverty	84.31	88.09	92.98	93.85

Source of data: US Census American Community Survey, 2011-2015
*Data are for 15 entire census tracts, including block groups that are not in the study area

- The study area, Suffolk County and New York State excluding New York City, are less racially diverse than the state as a whole, with a greater percentage of people who report themselves as white and lower percentages of persons reporting themselves as black, American Indian/Alaskan Native, Asian, of other races, or more than one race.

- The percentage of people in the study area who report themselves as Hispanic is similar to the percentage for all of Suffolk County, which is similar to New York State as a whole but somewhat higher than New York State excluding New York City.
- Educational levels, percent foreign born, and poverty status in the study area and Suffolk County are more similar to those for New York State excluding New York City, than to the state as a whole.
- The study area is generally similar to the Suffolk County average.
- When individual census tracts are examined, there is some variation within the study area (see Appendix 2, Table 1c).

Cancer Findings

Table 2 shows the findings from the Environmental Facilities and Cancer Mapping Project that led to the designation of the Centereach/Farmingville/Selden area as part of the Governor's Cancer Research Initiative. All of the excesses were statistically significant, meaning they were unlikely to occur by chance. More detailed data, including confidence intervals, may be found in Appendix 2, Table 1d (first four columns).

Table 2. Cancers in excess in the Centereach/Farmingville/Selden study area, 2011-2015

Cancer	Observed number of cases	Percent excess
Lung	311	56
Bladder	112	50
Thyroid	98	43
Leukemia	87	64

Source of data: New York State Cancer Registry

The Environmental Facilities and Cancer Mapping Project adjusted for the age and sex distribution of the study area, but did not adjust for such factors as race, ethnicity, socioeconomic status, percent foreign born, or other factors that can affect cancer patterns. When expected numbers of cases are computed based on rates for New York State excluding New York City, a comparison area more similar in terms of demographics and socioeconomic

Table 3. Observed and expected number of cancer cases, 2011-2015, Centereach/Farmingville/Selden study area, Suffolk Co., with expected numbers of cases calculated based on two standards

Site	CFS study area	NYS Standard		NYS excl. NYC Standard	
	Observed	Expected	Percent excess	Expected	Percent excess
Lung/bronchus	**311**	**199.3**	***56**	**222.0**	***40**
Urinary Bladder (including in situ)	**112**	**74.8**	***50**	**86.3**	***30**
Thyroid	**98**	**68.5**	***43**	**67.3**	***46**
Leukemia	**87**	**53.1**	***64**	**57.7**	***51**

Source of data: New York State Cancer Registry
Expected values are based on standard rates for 2011-2015 and block group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total populations: 160,539 males and 162,538 females
*Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

factors to the study area, somewhat different results were obtained. Table 3 compares the results obtained when using different comparison areas. (A table with confidence intervals may be found in Appendix 2, Table 1d.)

When the more similar region, New York State excluding New York City, was used as the comparison area,

- The excess in lung cancer was reduced from 56% to 40%.
- The excess in bladder cancer was reduced from 50% to 30%.
- The excess in thyroid cancer did not change appreciably.
- The excess in leukemia was reduced from 64% to 51%.
- All the excesses remained statistically significant.

The remainder of the cancer analyses were conducted based on a New York State excluding New York City standard except where noted.

Lung Cancer

Risk Factors

Although rates have declined in recent years, lung cancer remains the leading cause of death from cancer for both men and women in the United States[1]. Cigarette smoking is generally considered to be the most important risk factor for this disease; in fact, according to the American Lung Association between 80% and 90% of all lung cancer cases in the United States may be attributed to smoking[2]. Second hand smoke is also a risk factor[3]. It is important to understand, however, that factors other than smoking can cause lung cancer. For example, ionizing radiation to the chest from medical procedures has been associated with lung cancer[4]. As with many cancers, a positive family history is a risk factor[5]. Some studies suggest that dietary factors such as the consumption of fruits and vegetables may protect against lung cancer, but the evidence supporting this idea is uncertain[6].

Regarding environmental exposures, radon is believed to be an important cause of lung cancer[7]. Radon is a colorless and odorless radioactive gas that is a product of uranium. It occurs naturally in rock and soil and enters homes through the basement. In fact, the Environmental Protection Agency believes that residential exposure to radon may be second only to cigarette smoking as a cause of lung cancer in the United States[8]. Air pollution, including small particles and toxic substances, has been related to lung cancer[9]. Exposure to other chemicals and substances that can cause lung cancer occurs primarily (but not exclusively) in the workplace. Most notably, these include asbestos and arsenic, as well as chloromethyl ethers, beryllium, chromium, cadmium, nickel, silica, diesel exhaust, and soot[10].

Study Findings

Age and sex. Table 4 shows observed and expected numbers of lung cancer diagnoses in the Centereach/Farmingville/Selden study area by sex and broad age group. A table showing confidence intervals may be found in Appendix 2, Table 2a-1.

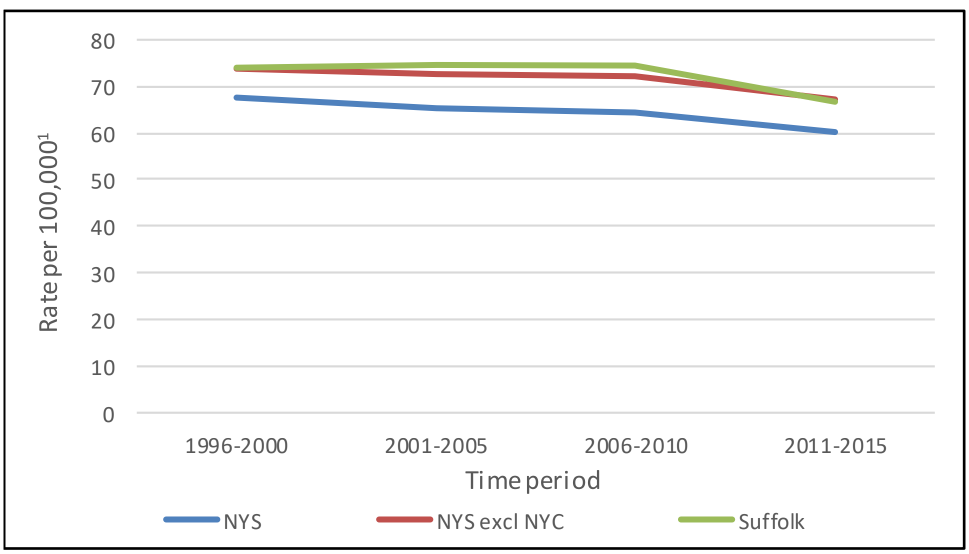
Table 4. Observed and expected number of lung cancer cases, by sex and broad age group, Centereach/Farmingville/Selden Study Area, Suffolk County, 2011-2015

Age group	Males			Females		
	Observed	Expected	Percent excess	Observed	Expected	Percent excess
0 - 19 years	0	0.0	0	0	0.0	0
20 - 49 years	8	4.7	72	8	5.7	41
50 - 64 years	35	34.0	3	42	36.0	17
65+ years	**111**	**69.5**	***60**	**107**	**72.2**	***48**
All ages	**154**	**108.2**	***42**	**157**	**113.9**	***38**

Source of data: New York State Cancer Registry
Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
*Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

- For all ages combined, similar statistically significant excesses were present in both males and females.
- Numbers of cancer cases observed were greater than the numbers expected in all adult age groups.
- Older adults (ages 65+) accounted for most of the excess, and most of the cases, in both males and females.

Figure 2. Lung cancer incidence by five-year time period, males and females combined, New York State, New York State Excluding New York City, and Suffolk County, 1996-2015



Source of data: New York State Cancer Registry
[1] Age-adjusted to the 2000 US population

Trends over Time. Data on lung cancer incidence were not routinely tabulated at the block group level prior to 2005. Figure 2 compares lung cancer incidence for males and females combined in Suffolk County with that for New York State and New York State excluding New York City by five-year time period going back to 1996. (Detailed data may be found in Appendix 2, Table 2a-2.)

- Lung cancer incidence in Suffolk County and New York State excluding New York City, was consistently above that for New York State as a whole.
- Rates in New York State and New York State excluding New York City, declined throughout this time period, while rates for Suffolk County did not begin to decline until 2006-2010.
- Rates in Suffolk County were similar to those in New York State excluding New York City in 1996-2000 and 2011-2015, but were above the New York State excluding New York City rates in the intervening time periods.

Starting for cases diagnosed 1993-1997, the New York State Cancer Registry began to tabulate observed and expected numbers of cases of the four most frequently diagnosed cancers (female breast, prostate, lung and colorectal) statewide on the ZIP Code level. Expected numbers of cases were calculated based on a statewide standard. As shown on the map (Figure 1), the closest approximation of the CFS study area on the ZIP Code level is ZIP Codes 11720, 11738 and 11784. Cancer incidence was tabulated on the block group level in a previous version of the Environmental Facilities and Cancer Mapping application, covering years 2005-2009. Summary findings of the tabulations by ZIP Code and Census block group are shown in Table 5. Detailed tabulations of observed and expected numbers of lung cancer cases by sex and individual ZIP Code may be found in Appendix 2, Table 2a-3.

Table 5. Observed and expected numbers of lung cancer cases in the Centereach/Farmingville/Selden Study area, males and females combined, by geographic level and time frame, 1993-1997 to 2005-2009

Geographic level	Time frame	Observed	Expected	Percent excess	Comments
ZIP Code[1]	1993-1997	**199***	**155.2**	**28**	ZIP Code 11720 included in an area of elevated lung cancer incidence for females
ZIP Code[1]	1999-2003	**229***	**184.5**	**24**	Areas of elevated incidence not determined
Census block groups	2005-2009	**244***	**192.7**	**27**	14 of the 39 block groups included in an area of elevated lung cancer incidence

Source of data: New York State Cancer Registry
[1]Includes ZIP Codes 11720, 11738 and 11784, approximating the study area
***Significant difference between observed and expected at the p < 0.05 level (two-sided).**

- Lung cancer incidence in the CFS study area and areas approximating it has been moderately elevated compared with New York State at least as far back as 1993-1997.

Cell Type. Most lung cancers fall into one of two categories: small cell and non-small cell lung cancers. There are three subtypes of non-small cell lung cancers: adenocarcinoma, squamous cell carcinoma, and large cell carcinoma. Although smoking increases the risk for all types of lung cancer, the risk is greatest for small cell and squamous cell carcinomas, and weakest for adenocarcinomas[11-13]. Observed and expected numbers of the different major types of lung cancer are shown Table 6. A table with confidence intervals may be found in Appendix 2, Table 2a-4.

Table 6. Observed and expected numbers of lung cancer cases by type of lung cancer, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Type	Observed	Expected	Percent excess
Small cell lung cancer	**44**	**27.0**	***63**
Non-small cell lung cancer			
Squamous cell carcinoma	52	45.0	16
Adenocarcinoma	**147**	**101.8**	***44**
Large cell carcinoma	17	12.7	34

Source of data: New York State Cancer Registry
Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group-level populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
*Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

- Adenocarcinoma was the most frequently diagnosed type of lung cancer, and the most frequent type expected.
- The largest elevations were in small cell lung cancers, which are most closely related to smoking, and adenocarcinomas, which are least closely related to smoking.
- Elevations in squamous cell carcinoma and large cell carcinoma were smaller, and not statistically significant.

Smoking Status. The Cancer Registry collects information on tobacco use status for people diagnosed with cancer. Of the people who had ever used tobacco, the vast majority had smoked cigarettes. Tobacco use for people in the CFS study area with lung cancer are displayed in Table 7 by type of lung cancer.

- Most people with the most common types of lung cancer reported a history of using tobacco at some time in their lives.
- The percent who had never used tobacco was smallest for squamous cell carcinoma and small cell lung cancer, the types of lung cancer

Table 7. Percent of lung cancer patients who reported never having used tobacco by type of lung cancer, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Type	Percent reported as never having used tobacco
Small cell lung cancer	4.6
Non-small cell lung cancer	
Squamous cell carcinoma	1.9
Adenocarcinoma	6.8
Large cell carcinoma	5.9

Source of data: New York State Cancer Registry

most strongly related to cigarette smoking.

Stage at time of diagnosis. Screening for lung cancer by means of low-dose computed tomography became available only recently. The US Preventive Services Task Force first recommended it in December 2013 for heavy smokers age 50-80 who are still smoking or have quit within the past 15 years[14]. The technique has been shown to detect cancers at a stage early enough that treatment can increase chances of survival. Widespread implementation of lung cancer screening would result in a greater proportion of lung cancers diagnosed at an early stage and increase the overall incidence of lung cancer, at least temporarily. To see whether any evidence of increased screening is present in the CFS area, we examined the stage distribution of lung cancers diagnosed in the CFS study area in comparison with New York State excluding New York City. Results are shown in Table 8.

Table 8. Lung cancer cases by stage at diagnosis, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, compared with New York State excluding New York City, 2011-2015

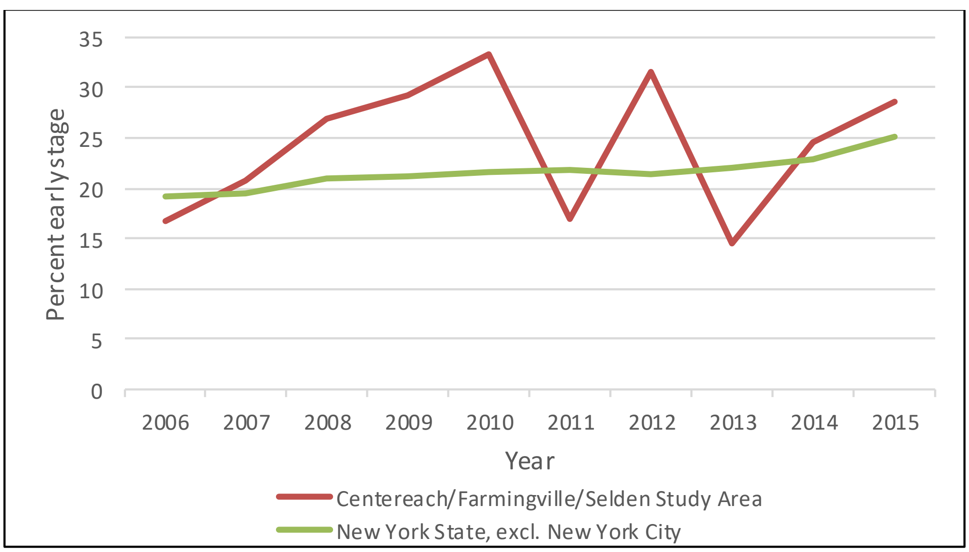
Stage at diagnosis	CFS Study Area	NYS excl. NYC
	Percent	Percent
Local	23.2	22.7
Regional	27.0	22.6
Distant	43.7	47.5
Unknown	6.1	7.2

Source of data: New York State Cancer Registry

- The proportions of cancers diagnosed at different stages were not significantly different in the study area and New York State excluding New York City.

Changes over time in the distribution of the stage of disease at the time of diagnosis were also examined in the study area and the comparison area. Figure 3 illustrates these changes. Detailed data may be found in Appendix 2, Table 2a-5.

Figure 3. Percent of lung cancers diagnosed at an early stage, males and females combined, Centereach/Farmingville/Selden study area and New York State excluding New York City, 2011-2015



Source of data: New York State Cancer Registry

- In the study area, the percent of lung cancers diagnosed at an early stage was highly variable from year to year. This is probably related to the relatively small number of cases diagnosed at each stage in a single year.

Mortality. In the study area for 2011-2015, there were 205 deaths from lung cancer, compared with 138.4 expected (based on the New York State excluding New York City standard). This 48% excess was statistically significant. The size of the excess is comparable to the 40% excess in new cases observed in the CFS study area (based on the New York State excluding New York City standard). Not all of the people who had died between 2011 and 2015, however, would have been diagnosed between 2011 and 2015.

Summary of Cancer Findings

The excess in lung cancer cases was present in both males and females. Older adults, ages 65 and older, accounted for most of the elevated number of cases. Lung cancer incidence in the Centereach/Farmingville/Selden study area has been elevated at least as far back as 1993-1997, although the elevations seen in previous years were not as great as in 2011-2015. Elevations were present for all major types of lung cancer, with the greatest percent elevations found for small cell lung cancer, the type most closely related to smoking, and adenocarcinoma, the type that is least strongly related to smoking. As expected, most of the people with lung cancer had a history of smoking at some time in their lives, and the proportion who had never smoked was smallest for the types most closely associated with smoking. The percent of lung cancers diagnosed at an early stage in the study area was highly variable from year to year. The average percent diagnosed at an early stage was similar to that of New York State excluding New York City. Mortality, or death, from lung cancer was greater than expected in the study area, reflecting the higher than expected incidence and the high death rates associated with this cancer.

Bladder cancer

Risk Factors

The bladder is part of the urinary system, and stores urine. The most important risk factor for this cancer is cigarette smoking. It is estimated that smoking is responsible for up to 50% of all bladder cancer cases[1]. Workplace exposures are also important and may account for as many as 20% of bladder cancers[2]. Elevated risks have been found among rubber, plastic, dye, and metal workers, hairdressers, painters, and bus and truck drivers[3]. Specific substances linked to bladder cancer in these occupations include aromatic amines (used in dyes), diesel exhaust, and polycyclic aromatic hydrocarbons (formed during the incomplete burning of coal, oil, gas, wood, or other organic substances)[4].

High levels of arsenic in drinking water increase the risk of bladder cancer[5]. Some studies have also found that lifetime consumption of drinking water contaminated with disinfection by-products is associated with a greater risk of this cancer[6]. Other risk factors include family history[7], exposure to radiation[8], a diet low in fruit and vegetables[9] and some drugs used to treat cancer[10] or diabetes[11]. Increased fluid intake may reduce the risk of bladder cancer because it increases the frequency of urination, which limits the amount of time cancer-causing chemicals are in contact with the bladder[12].

Study Findings

Age and sex. Table 9 below shows observed and expected numbers of bladder cancer diagnoses in the study area by broad age group. To protect patient confidentiality, numbers of males and females in each age category were combined, although statistical comparisons were done for males and females separately. A table showing confidence intervals may be found in Appendix 2, Table 2b-1.

Table 9. Observed and expected number of bladder cancer cases, by sex and broad age group, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

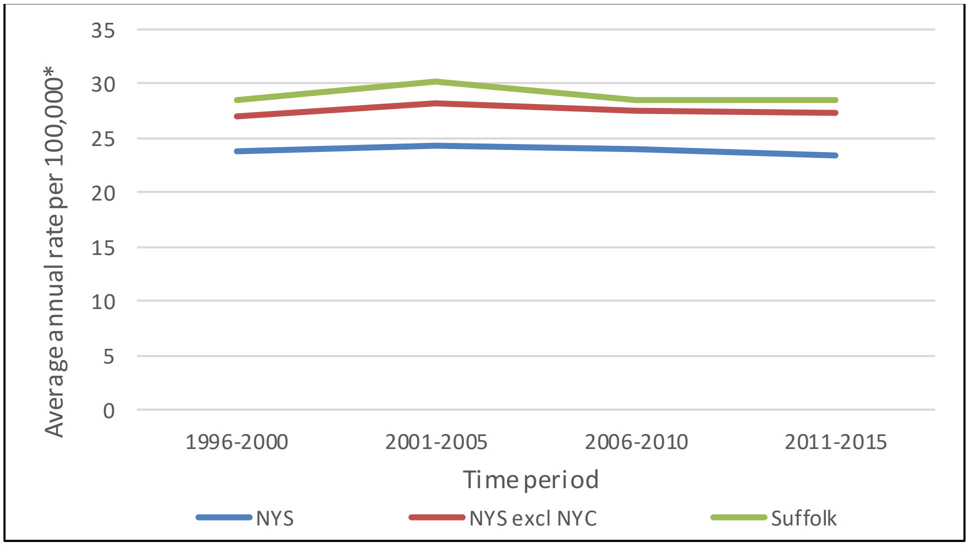
Age group	Males and Females		
	Observed	Expected	Percent excess
0 - 19 years	0	0.0	0
20 - 49 years	7	4.4	58
50 - 64 years	29	23.6	23
65+ years	**76**	**58.2**	***31**
All ages	**112**	**86.3**	***30**
Males	**83**	**63.9**	***30**
Females	29	22.4	30

Source of data: New York State Cancer Registry
Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

- The number of cancer cases among older adults (age 65 and over) was statistically significantly greater than expected. This excess was statistically significant in males (61 cases observed, 43.6 cases expected, 40% excess), but not in females (15 cases observed, 14.6 expected, 3% excess).
- The percentage excesses in bladder cancer cases were the same in males and females of all ages. The excess was statistically significant in males, but not in females.
  - The largest percent excess among females was in middle-aged adults (ages 50-64) (numbers not shown to protect confidentiality). This excess was of borderline statistical significance (p=0.034).

Trends over Time. Data on bladder cancer incidence were not routinely tabulated at the block group level prior to 2005. Figure 4 below compares bladder cancer incidence for males and females combined in Suffolk County with that for New York State and New York State excluding New York City by five-year time period going back to 1996. More detailed data may be found in Appendix 2, Table 2b-2.

Figure 4. Bladder cancer incidence by five-year time period, males and females combined, New York State, New York State Excluding New York City, and Suffolk County, 1996-2015



Source of data: New York State Cancer Registry
*Age-adjusted to the 2000 US population

- Bladder cancer incidence in Suffolk County and New York State excluding New York City, was consistently above that for New York State as a whole.
- Rates in all three areas remained fairly stable throughout this time period.
- Rates in Suffolk County were above those in New York State excluding New York City in 2001-2005.

Cancer incidence was tabulated on the block group level in a previous version of the Environmental Facilities and Cancer Mapping application, covering years 2005-2009. In this time period, there were 82 cases of bladder cancer observed in the 39 block groups of the study area combined, compared with 69.4 expected (based on a New York State standard), an elevation of 18%. This is similar to the 19% greater incidence of bladder cancer in Suffolk County as a whole compared to New York State seen in 2006-2010. None of the block groups in the Centereach/Farmingville/Selden study area was included in any areas of elevated bladder cancer incidence for 2005-2009.

Cell Type. The three main types of bladder cancer are transitional cell carcinoma (also known as urothelial carcinoma), squamous cell carcinoma, and adenocarcinoma. Transitional cell carcinoma, including papillary carcinoma not otherwise specified, accounts for a large majority of all bladder cancers. Squamous cell carcinoma accounts for about 2% of all bladder cancers and adenocarcinoma about 1%. Table 10 shows the distribution of bladder cancer cell type for the study area compared with New York State excluding New York City. Additional information may be found in Appendix 2, Table 2b-3.

- As expected, transitional cell carcinoma was by far the most frequently diagnosed type of bladder cancer in the study area. This subtype accounted for the excess in bladder cancers.

- Numbers of cases of other types of bladder cancer were small, and not significantly different from the numbers expected.

Table 10. Observed and expected numbers of bladder cancer cases by type of bladder cancer, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Type	Observed	Expected[1]	Percent excess
Transitional cell	**107**	**82.1**	***30**
Squamous cell	1	0.8	24
Adenocarcinoma	1	0.6	74
Other[2]	3	2.9	5

Source of data: New York State Cancer Registry
[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
[2] Other includes other specified and unspecified carcinomas, other specified and unspecified malignant neoplasms, and sarcomas.
***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

A community member had expressed concern over cases of micropapillary bladder cancer in the community. Micropapillary transitional cell carcinoma of the bladder is rare, accounting for less than 1 percent of all bladder cancers. It is grouped with transitional cell carcinomas in the table above. When this subtype was examined separately, the proportion of bladder cancers with this subtype was similar to that for the comparison population.

Smoking Status. The Cancer Registry collects information on tobacco use for people diagnosed with cancer. For those with a known tobacco use status, 18% of people in the CFS study area who were diagnosed with bladder cancer were reported to have never used tobacco.

Mortality. In the study area for 2011-2015, there were 18 deaths from bladder cancer, compared with 13.4 expected (based on the New York State excluding New York City standard). This 35% excess was not statistically significant but was comparable in size to the 30% excess in incidence.

Summary of Cancer Findings

Bladder cancer incidence was elevated to a similar extent in males and females. Older males, ages 65 and older, accounted for most of the excess cases. There was also suggestive evidence of a greater than expected number of middle-aged females with bladder cancer. Bladder cancer rates have been elevated in Suffolk County compared to the rest of the state at least as far back as 1996, however rates in the study area were not above those in the county as a whole until 2011-2015. The vast majority of bladder cancer cases in the study area were the papillary cell type, similar to that in New York State excluding New York City, and the number of cases of a rare cell type that was of concern to a member of the public did not appear elevated. As expected, most people with bladder cancer were current or former smokers at the time they were diagnosed, although the percent of people with bladder cancer who had ever smoked was less than the percent of people with lung cancer who had ever smoked. The number of deaths from bladder cancer in the study area was also greater than expected, although this finding was based on relatively small numbers and could have occurred by chance.

Thyroid cancer

Risk Factors

Many recent studies and review articles have concluded that the primary risk factor for thyroid cancer is the medical system itself – specifically, receiving a neck ultrasound or other form of imaging in the absence of any symptoms or expectation of future symptoms[1-3]. An 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[1].

The next most important modifiable risk factor for thyroid cancer is exposure to ionizing radiation[4-5], particularly at a young age[6-8]. Sources of ionizing radiation exposure include medical procedures such as x-rays[9-10] and CT scans[6, 9], radiation treatment for a previous cancer[11], emissions from nuclear accidents[7, 12], and fallout from above-ground nuclear weapons testing[5, 13]. There is also evidence that a diet low in iodine is associated with increased risk of the follicular subtype of thyroid cancer[14]. In addition, excess body fat is associated with thyroid cancer, although the increase in thyroid cancer risk is modest[15-16].

Non-modifiable risk factors for thyroid cancer include hereditary conditions such as mutations in the *RET* gene[17-18], familial adenomatous polyposis[19-20], Cowden disease[19-21], and Carney complex type I[19-20]. Familial nonmedullary thyroid carcinoma[22] and a family history of thyroid cancer[23] also increase the risk, although family history is itself entwined with overdiagnosis - family members of those who have been diagnosed through medical imaging are themselves more likely to request or be recommended for the same imaging[2, 23-24].

Study Findings

Age and Sex. Table 11 shows observed and expected numbers of thyroid cancer diagnoses in the study area by sex and broad age group. To protect patient confidentiality, the two youngest age groups were combined, as were the numbers of males and females in each age category. Statistical comparisons were done for males and females separately and combined in each age group. Additional data may be found in Appendix 2, Table 2c-1.

- The number of cancer cases in the age group 0-49 years was statistically significantly greater than expected. This excess was statistically significant in males (15 cases observed, 7.3 cases expected, 106% excess), but not in females (35 cases observed, 26.7 cases expected, 31% excess).

  - Most of the people in this age group diagnosed with thyroid cancer were young adults (ages 20-49), although there was a small number of children. The number of young adults taken separately was significantly greater than expected. This excess was statistically significant in males, but not in females (numbers not shown to protect patient confidentiality).

- The number of cancer cases among older adults (age 65 and older) was statistically significantly greater than expected. This excess was statistically significant in males (9 cases observed, 3.9 cases expected, 131% excess), but not in females (13 cases observed, 7.1 cases expected, 82% excess).
- More females than males of all ages were diagnosed with thyroid cancer, however more females than males were expected to have been diagnosed. Thyroid cancer was significantly elevated in both males and females. The size of the elevation was greater in males.

Table 11. Observed and expected number of thyroid cancer cases, by sex and broad age group, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

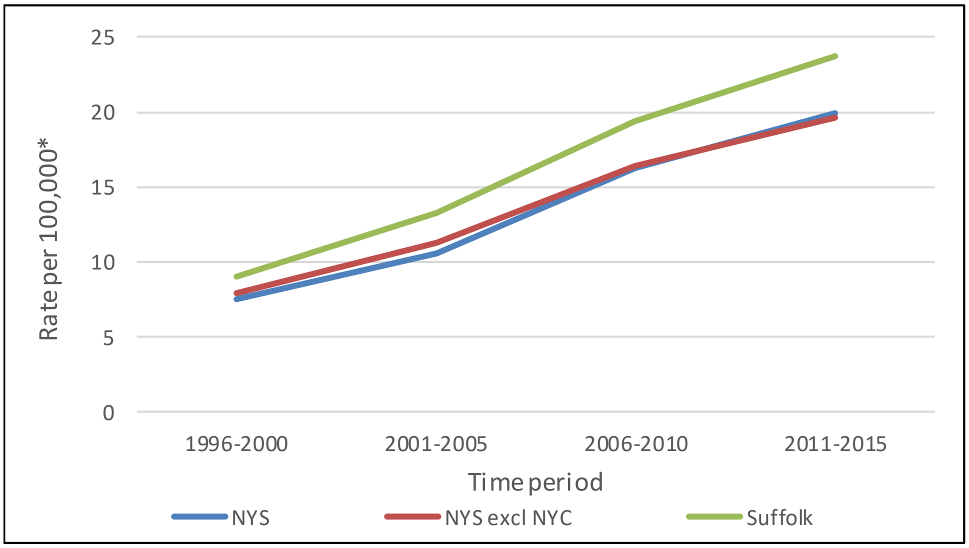
Age group	Males and Females		
	Observed	Expected	Percent excess
0 - 49 years	**50**	**34.0**	***47**
50 - 64 years	26	22.3	17
65+ years	**22**	**11.0**	***99**
All ages	**98**	**67.3**	***46**
Males	**32**	**17.5**	***83**
Females	**66**	**49.8**	***32**

Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

Trends over Time. Data on thyroid cancer incidence were not routinely tabulated at the block group level prior to 2005. Figure 5 compares thyroid cancer incidence for males and females combined in Suffolk County with that for New York State and New York State excluding New York City by five-year time period going back to 1996. Additional data may be found in Appendix 2, Table 2c-2.

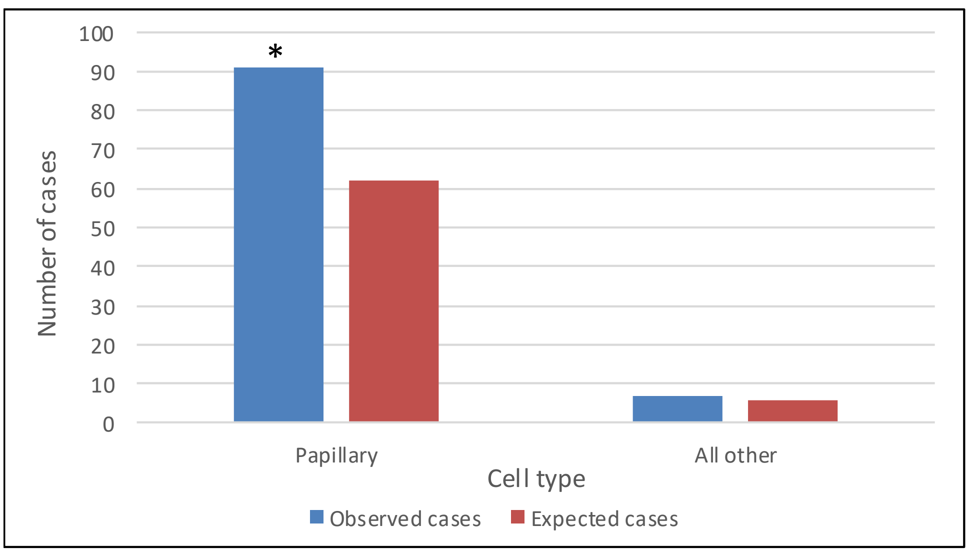
- Thyroid cancer incidence in Suffolk County was consistently above that for New York State excluding New York City, as well as for New York State as a whole.
- Thyroid cancer incidence increased at about the same rate in all three areas throughout this time period.

Figure 5. Thyroid cancer incidence by five-year time period, males and females combined, New York State, New York State Excluding New York City, and Suffolk County, 1996-2015



Source of data: New York State Cancer Registry
*Age-adjusted to the 2000 US population

Figure 6. Observed and expected numbers of cases of thyroid cancer by cell type, papillary and all other types, Centereach/Farmingville/Selden study area, Suffolk County, males and females combined, 2011-2015



Source of data: New York State Cancer Registry
Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

In the previous version of the Environmental Facilities and Cancer Mapping application, covering years 2005-2009, there were 78 cases of thyroid cancer observed in the 39 block groups of the study area combined, compared with 50.0 expected (based on a New York State standard), an elevation of 56%. The Centereach/Farmingville/Selden study area was included in an area of elevated thyroid cancer incidence for this time period. The elevation in the Centereach/Farmingville/Selden study area in 2005-2009 was over and above the 18% elevation in Suffolk County as a whole in 2006-2010 compared to New York State and New York State excluding New York City.

Cell Type. There are four main types of thyroid cancer. The most common type is papillary thyroid cancer. This type of thyroid cancer accounts for about 93% of all thyroid cancers in New York State. The other three main types of thyroid cancers are follicular, medullary, and anaplastic. Figure 6 shows observed and expected numbers of cases of papillary and all other types of thyroid cancer for the study area. More detailed data and breakdowns for individual cell types other than papillary are available in Appendix 2, Table 2c-3.

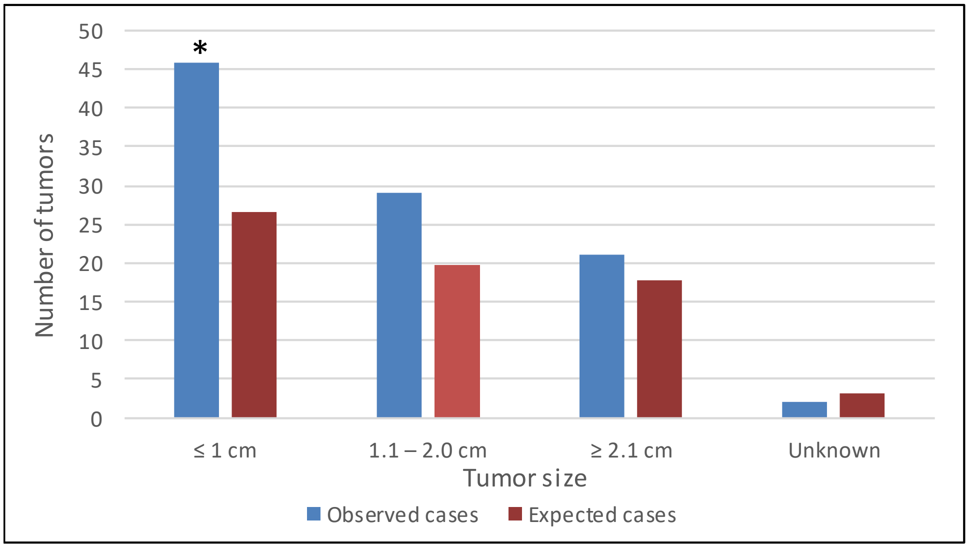
- The number of cases of papillary thyroid cancer diagnosed among study area residents was significantly greater than the number expected. Papillary thyroid cancer accounts for almost all of the excess in thyroid cancer cases.
- The number of cases of all other types of thyroid cancer was similar to the number expected. There were no significant differences for any other single type when taken separately (see Appendix 2, Table 2c-3).

Tumor Size. The incidence of thyroid cancer has been increasing for the last few decades in New York State as well as nationally. It has been estimated that between 1988 and 2002, 87% of the increase seen in the National Cancer Institute's Surveillance, Epidemiology and End Results system of cancer registries was due to tumors measuring less than 2 cm in greatest dimension[25]. This supports the idea that the increase was largely due to the greater detection of existing tumors by increasingly sensitive diagnostic techniques, such as ultrasound and fine-needle aspiration. Figure 7 shows observed and expected numbers of cases of thyroid cancer in the Centereach/Farmingville/Selden study area by size of the tumor. More detailed data on tumor size and stage at diagnosis are available in Appendix 2, Tables 2c-4 and 2c-5.

- Thyroid tumors of size 2.0 cm or less accounted for most of the excess in thyroid cancer in the Centereach/Farmingville/Selden study area.
- The number of thyroid cancers with a tumor size of ≤ 1 cm was statistically significantly greater than expected.

Mortality. Thyroid cancer, especially the papillary type, is rarely fatal. In the study area for 2011-2015, there were 2 deaths from thyroid cancer, compared with 1.6 expected (based on the New York State excluding New York City standard).

Figure 7. Observed and expected numbers of thyroid cancer cases, by tumor size, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015



Source of data: New York State Cancer Registry
Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

Summary of Cancer Findings

Thyroid cancer was elevated in both males and females. While the number of females with thyroid cancer was greater than the number of males, the percent elevation was greater in males, since males generally have much lower rates of thyroid cancer than females. Numbers of cases identified were greater than the numbers expected in almost all age groups, with the greatest elevation found in persons age 65 and older. Thyroid cancer rates have been elevated in Suffolk County compared to the rest of the state at least as far back as 1996, and rates in the study area were elevated even over the Suffolk County rate in 2005-2009. As expected, most thyroid cancers in the study area were the papillary type, and this type accounted for almost all of the excess. Most of the excess in thyroid cancer was in tumors of 2 cm or less in greatest dimension. The number of deaths from thyroid cancer was not elevated, although deaths from this cancer, especially the papillary type, are rare.

Leukemia

Risk Factors

Leukemias are cancers of the blood cells. There are four major types of leukemia, distinguished by how quickly the disease progresses (acute vs. chronic), and the type or types of blood cells affected. The different leukemias have somewhat different, but overlapping, sets of risk factors. The four major types of leukemia and their risk factors are discussed separately below.

Acute lymphocytic leukemia (ALL) starts in cells that become lymphocytes, a type of white blood cell. It differs from chronic lymphocytic leukemia (CLL) in that more of the abnormal cells are immature, and it progresses more rapidly. ALL is the most common type of leukemia in children but also affects adults, especially those 65 years of age or older.[1] Childhood ALL is associated with certain genetic conditions such as Down syndrome.[2] Ionizing radiation, including exposure of the mother while pregnant, increases the risk of ALL.[3] Some early studies suggested an increased risk from non-ionizing radiation such as electromagnetic fields,[4] but more recent studies indicate that this may only be when the strength of the fields is very high.[5] High birthweight (usually defined as >4,000 g/8 lbs. 13 oz.) is a risk factor for childhood ALL.[6] Children with allergies may be at lower risk,[7] and some studies have suggested that childhood infections are involved, but no specific virus has been identified.[8] Parental smoking, alcohol consumption, and diet have also been investigated as risk factors for childhood ALL, but the results are inconclusive.[9] In regard to chemical exposures, some studies have linked maternal occupational exposures to hydrocarbons[10] and other chemicals[11] to childhood ALL. There is also evidence to suggest that both child and parental exposures to insecticides may increase the risk of childhood ALL.[12] Numerous studies have examined exposure to air pollution from motor vehicle exhaust and childhood ALL, but the findings are inconsistent.[13,14]

Regarding adult ALL, employment in industries related to petroleum, rubber, automobile manufacturing, nuclear energy, electronics, munitions, dye manufacturing, and plastics may increase the risk.[15] Some studies have also linked the use of hair dyes to ALL in adults, but the results are inconsistent.[16] A rare type of ALL called adult T-cell leukemia is caused by the HTLV-1 virus, but this virus is extremely uncommon in the United States.[17]

Acute myeloid leukemia (AML) most often develops from cells that would turn into white blood cells (other than lymphocytes), but sometimes develops in other types of blood-forming cells. It differs from chronic myeloid leukemia (CML) in that more of the abnormal cells are immature, and it progresses more rapidly. AML is the second most common form of leukemia in adults, but also affects children and adolescents.[1] Among children, genetic disorders such as Down syndrome are important risk factors for AML.[18] Ionizing radiation such as maternal X-ray exposure while pregnant is a well-established cause of childhood AML.[3] Studies suggest an increased risk with older maternal age[19] but not with paternal age.[20] There is also some evidence of an increased risk with increasing birth order,[21] but this could be due at least in part to maternal age. Overall, there appears to be an increased risk of childhood AML with prior pregnancy loss.[22] Maternal alcohol use during pregnancy may be a risk factor,[23] but maternal smoking does not appear to have an effect.[24] Maternal occupational exposure to pesticides is associated with increased risk but paternal exposure is not.[25] Children who were breast-fed for six months or more may be at lower risk of AML.[26]

Ionizing radiation is also a well-established cause of AML in adults,[27] as are several drugs used in chemotherapy.[28] Occupational exposure to benzene is a risk factor,[29] and persons occupationally exposed to embalming fluids, ethylene oxides, and herbicides also appear to be at increased risk.[30] Smoking is another risk factor – in fact, 15% of all cases of adult AML may be due to smoking.[31] An additional lifestyle risk factor is obesity, with obese persons having twice the risk of developing AML as those who are not obese.[32] An association between viruses and AML has been suggested but no specific viruses have been identified.[30]

Chronic lymphocytic leukemia (CLL) starts in cells that become lymphocytes, a type of white blood cell. It differs from acute lymphocytic leukemia (ALL) in that more of the abnormal cells are partly mature and partly functional, and it progresses more slowly. CLL is the most common type of leukemia in adults, but rarely affects children.[1] Family history is a strong risk factor,[33] but other causes of CLL are uncertain. For example, ionizing radiation is a well-established risk factor for most types of leukemia, but the evidence for CLL is mixed.[34] Early studies suggested that occupational exposures to non-ionizing forms of radiation such as electromagnetic fields increase the risk of CLL,[35] but later studies indicate that the association is weak and not conclusive.[36] Occupational exposure to chemicals such as benzene, ethylene oxide, 1-3 butadiene, and pesticides have been linked to CLL in some studies, but the findings are not consistent.[37] Autoimmune and allergic diseases do not appear to increase the risk of CLL,[38] but some studies suggest that pneumonia may be a risk factor.[39] There is little evidence that lifestyle factors such as smoking[40] and diet[41] are important in developing CLL.

Chronic myeloid leukemia (CML) is also known as chronic myelogenous leukemia. It is a cancer of myeloid cells, the cells that make most types of white blood cells (other than lymphocytes), red blood cells, and cells that make platelets. It differs from acute myeloid leukemia (AML) in that more of the abnormal cells are partly mature and partly functional, and it progresses more slowly. CML, rare in children and adolescents, is most commonly diagnosed among adults 65 years of age and older.[42] Ionizing radiation is believed to be a risk factor,[43] but otherwise the causes of CML are poorly understood.[44] There is some evidence that smoking may increase the risk of CML,[45] but the association is not as strong as it is for AML. Family history does not appear to be important,[46] nor does alcohol consumption.[47] Certain types of chemotherapy may increase the risk of CML, but this is rare.[48] Some scientists have suggested that occupational exposure to benzene and pesticides may be involved, given their association with AML,[42] but the evidence for their relationship to CML is unclear.[49,50]

Study Findings

Age and Sex. Leukemia incidence was examined in different age groups in males and females. To protect patient confidentiality, in Table 12 numbers of males and females in each age category were combined, although statistical comparisons were done for males and females separately. Additional data may be found in Appendix 2, Table 2d-1.

- The number of children (ages 0-19) who had been diagnosed with leukemia was significantly greater than the number expected, with almost three times as many cases actually identified as expected. The excess was statistically significant in boys, but not in girls (numbers not shown).
- The number of older adults (age 65 and over) who had been diagnosed with leukemia was significantly greater than expected. This excess was statistically significant in

females (24 cases observed, 12.4 expected, 94% excess), but not in males (24 cases observed, 17.4 expected, 38% excess).

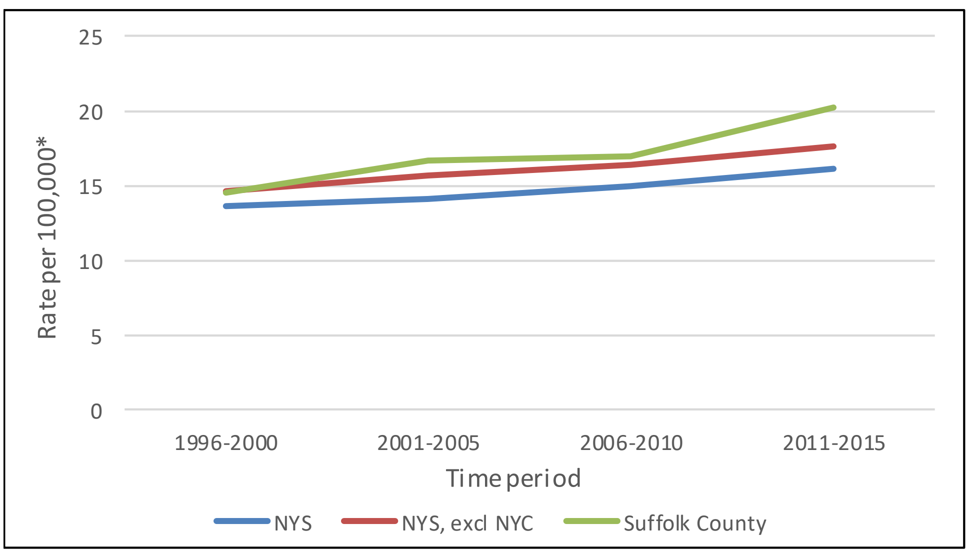
- There was a statistically significant excess in numbers of cases among males of all ages.
- The number of females of all ages who had been diagnosed with leukemia was not significantly greater than expected.

Table 12. Observed and expected number of leukemia cases, by age group, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Age group	Males and Females		
	Observed	Expected	Percent excess
0 - 19 years	**11**	**3.7**	***196**
20 - 49 years	10	7.8	29
50 - 64 years	18	16.5	9
65+ years	**48**	**29.8**	***61**
All ages	**87**	**57.7**	***51**
Males	**53**	**33.7**	***57**
Females	34	24.1	41

Source of data: New York State Cancer Registry
Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
* Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

Figure 8. Leukemia incidence by five-year time period, males and females combined, New York State, New York State Excluding New York City, and Suffolk County, 1996-2015.



Source of data: New York State Cancer Registry
*Age-adjusted to the 2000 US standard population.

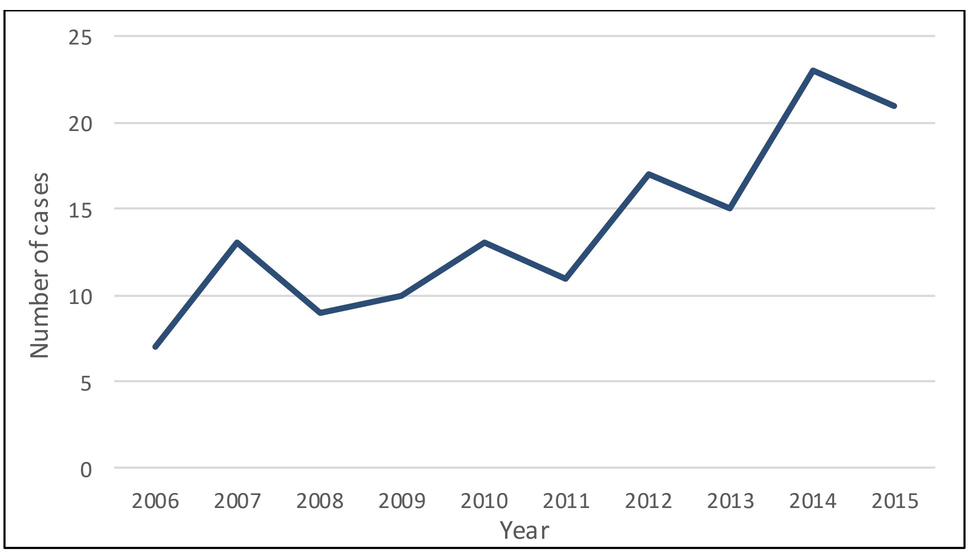
Trends over Time. Data on leukemia incidence were not routinely tabulated at the block group level prior to 2005. Figure 8 compares leukemia incidence rates for males and females combined in Suffolk County with that for New York State and New York State excluding New York City by five-year time period going back to 1996. Detailed data may be found in Appendix 2 Table 2d-2.

- Leukemia incidence rates for all three areas increased from 1996-2000 to 2011-2015.
- The rate for New York State excluding New York City, was consistently above that for New York State as a whole.
- Rates for Suffolk County were generally similar to rates for New York State excluding New York City, until 2011-2015, when they were higher.

Cancer incidence was tabulated on the block group level for years 2005-2009 in a previous version of the Environmental Facilities and Cancer Mapping application. In this time period, there were slightly fewer cases of leukemia observed than expected in the 39 block groups of the study area, with 38 cases observed and 40.9 expected (based on a New York State standard). The CFS study area was not included in any areas of elevated leukemia incidence at that time.

Numbers of leukemia diagnoses in the study area were also examined by single year from 2006-2015. Figure 9 shows counts of total leukemia cases in the study area by single year. Exact numbers can be found in Appendix 2, Table 2d-3.

Figure 9. Leukemia cases diagnosed in the Centereach/Farmingville/Selden study area by year, 2006-2015

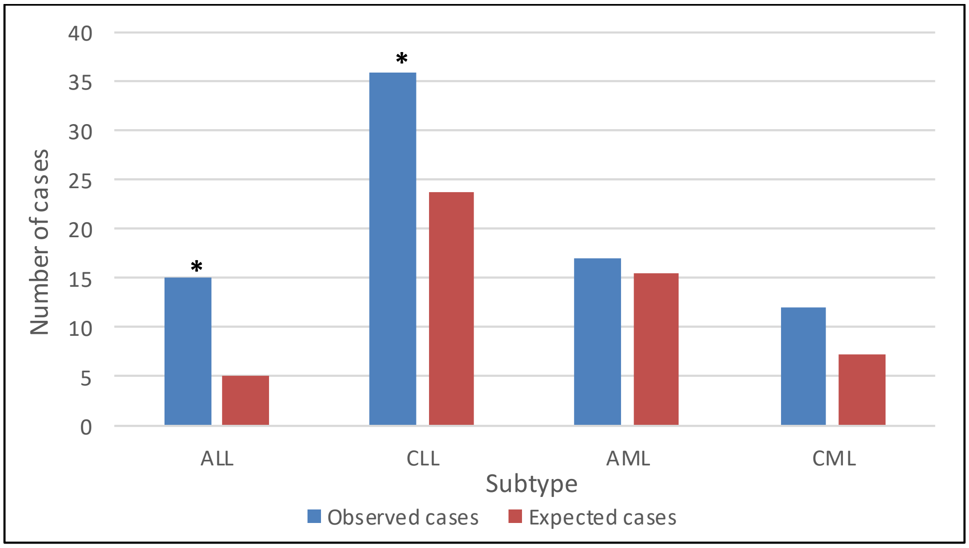


Source of data: New York State Cancer Registry

- The number of cases diagnosed in a year generally increased over time, with the greatest numbers of cases diagnosed in 2014 and 2015.

Leukemia Subtypes. Since they have somewhat different sets of risk factors, the different subtypes of leukemia were examined separately. Figure 10 shows observed and expected numbers of leukemia cases for the four major subtypes. There were also cases of various less frequently diagnosed types of leukemia. Detailed data may be found in Appendix 2, Table 2d-4.

Figure 10. Observed and expected numbers of leukemia cases, by leukemia subtype, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015



Source of data: New York State Cancer Registry
Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
* Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

- Most of the excess in numbers of leukemia cases can be accounted for by statistically significant excesses in numbers of cases of ALL and CLL.
- There was also a 65 percent excess in cases of CML. The size of this excess was similar to the 51 percent excess in cases of CLL, but due to the smaller numbers of cases, the difference in CML cases was not statistically significant.

Due to the significant excesses in ALL and CLL and the similar-size excess in CML, further analysis concentrated on these subtypes.

Subtypes by Age and Sex. The incidence of ALL, CLL and CML was examined in different age groups for males and females. (Numerical results are not presented due to small numbers of cases.)

- Numbers of cases of ALL were significantly elevated for children (ages 0-19) and for middle-age adults (ages 50-64). In both age groups, the excess was statistically significant in males, but not in females.

  - The total number of males of all ages with ALL was significantly greater than expected. The total number of females with ALL was similar to the number expected.
- Numbers of cases of CLL were significantly elevated for older adults (ages 65 and over). This excess was greatest, and statistically significant, in females. The number of males age 65 and older with CLL was also elevated, but this difference was not statistically
- significant.
- Numbers of cases of CML were greater than expected in most adult age groups, and particularly among older adults. Numbers were also elevated in males of all ages and females of all ages. None of these differences was statistically significant.

Subtypes by Year. We examined the incidence of all four major types of leukemia by single year between 2006 and 2015. (Numerical results are not presented due to small numbers of cases in a single year.)

- An increase with time in the number of cases was seen for ALL, CLL and AML taken separately. Numbers of cases per year of CML did not show any obvious trends.
- The greatest numbers of cases of ALL were diagnosed in 2014 and 2015.
- The greatest numbers of cases of CLL were diagnosed in 2010, 2013 and 2014.

Mortality. Leukemia is a disease that can often be controlled. In the study area for 2011-2015, there were 20 deaths from leukemia, compared with 20.1 expected (based on the New York State excluding New York City standard). When deaths from the different subtypes of leukemia were examined separately, numbers of deaths observed and expected for each individual subtype were small, but none had observed numbers that were significantly different from the numbers expected. It is important to remember that some of the people who died between 2011 and 2015 would have been diagnosed in earlier years, and some of the people diagnosed between 2011 and 2015 might have died in later years. The elevation of leukemia incidence but not mortality may reflect the longer survival times of people with chronic leukemias, the better prognosis of children with leukemia, and the fact that many of the cases of ALL occurred in the last years of the study period.

Further Analyses

The analyses above showed an elevated number of leukemias in children, and elevated numbers of cases of the chronic leukemias CLL and CML in people of all ages. These groups of cases were therefore examined more closely.

Childhood leukemias. As stated above, the elevation in numbers of childhood leukemia cases in general, and cases of ALL in particular, was statistically significant in boys, but not in girls. Ages of the children with leukemia at the time of their diagnoses ranged from pre-school to older teenagers. ALL is the most frequently diagnosed type of leukemia in children and was the most frequently diagnosed type of leukemia among children in the study area. One or more cases of AML, the second most frequently diagnosed type of leukemia among children, were also found.

To examine their geographic distribution, home addresses of the children at the time of their leukemia diagnosis were plotted on a map of the study area. Relatively few of the children lived in the Farmingville portion of the study area compared with Centereach and Selden, with most of the children living near or north of Middle Country Road. Two of the children, diagnosed within three years, lived within a quarter mile of each other, and another two lived within about a half mile of each other. None of the other children lived within a half mile of any other.

The home addresses of the children were also compared with the boundaries of the school districts in the area. Most of the CFS study area is in the Middle Country School District. When school district boundaries were overlain on the map of the children's addresses, most of the children with leukemia lived within the Middle Country School District.

Years of diagnosis of the children with leukemia were also examined. Over the five years studied, about half of the children were diagnosed in the last year of this period, 2015. Many of the children diagnosed in this year lived in the eastern and northern portions of the area, although none of them lived within a mile of any of the others. Most of the children diagnosed this year were school age or older, and most lived within the Middle Country School District.

Chronic leukemias. Leukemia diagnoses can occur more frequently in people who have had a prior cancer. For AML, ALL and CML, this may be due to the associations of these types of leukemia with therapies used to treat other cancers, such as radiation and certain types of chemotherapy. For CLL, the explanation is less clear. In the CFS study area, six of the people with CLL, or 17 percent, had a record of a prior tumor. This is comparable to the 19 percent of people with CLL in New York State excluding New York City, who had a prior tumor. For CML, three of the people in the study area with CML, or 25 percent, had a history of a prior tumor, compared to 20 percent of people with CML in the comparison area. Given the relatively small number of people in the study area with CML, this figure is also comparable.

Chronic leukemias can be detected by routine blood testing. At least in their early stages, they can be treated in a doctor's office, or may not be treated at all. A person with a chronic leukemia may therefore never be hospitalized for their condition. While the vast majority of acute leukemias are reported to the Cancer Registry by one or more hospital inpatient facilities, only about a third of people with CLL and just over half of people with CML are reported as inpatients. Other sources reporting appreciable numbers of cancer cases are diagnostic and treatment centers, physician practices, and hospital-based and independent clinical laboratories. The extent to which these other reporting sources report cancer cases may affect the recorded incidence of chronic leukemias.

To ensure that non-hospital sources are reporting all their leukemia cases, the Cancer Registry has been identifying and contacting specialty physician practices to remind them of their duty to report and assist them in complying. Efforts to reach practices on Long Island did not begin until late 2014, so would probably not have had a large effect on case reporting in the time frame of this study. To assess the role of physician reporting, individual database records for patients in the CFS study area diagnosed with CLL and CML were examined. Seven of the 36 patients with CLL and none of the 12 patients with CML were reported by physician offices but not by hospital inpatient or outpatient facilities or freestanding diagnostic/treatment centers. All of these physician reports, however, had come as the result of following back reports from laboratories, and none had come from physicians reporting on their own. There is thus no evidence of increased reporting of chronic leukemia cases by specialty physician practices in the CFS study area.

The Cancer Registry has also been working with independent clinical laboratories in the state to report cancer cases electronically, as they do for many other reportable diseases. Since 2005, these efforts have resulted in steadily increasing numbers of independent laboratories throughout the state reporting cancer cases, and by 2016 most major independent laboratories in the state were reporting. Of the 36 cases of CLL and 12 cases of CML diagnosed between 2011 and 2015 that were identified in the CFS study area, nine of the CLL cases, or 25%, and one of the CML cases (8%) had been reported by laboratories only. The percentage of CLL cases reported by laboratories only is comparable to the 26% of CLL cases in Suffolk County reported by laboratories only, but more than the 13% for New York State excluding New York City. The 8% of CML cases reported by laboratories only is comparable to the 11% of CML cases in Suffolk County and the 6% of cases in New York State excluding New York City reported by laboratories only.

Summary of Cancer Findings

The CFS study area showed a 51% excess in cases of leukemia when compared to New York State excluding New York City. Much of this excess was accounted for by higher than expected numbers of cases of leukemia, particularly ALL, among children, and higher than expected numbers of cases of the chronic leukemias CLL and CML among persons age 65 and older. Leukemia incidence in Suffolk County has been similar to that in New York State excluding New York City until the most recent five years, when it began to increase more rapidly. In the study area, the excess in leukemia cases was not present in the previous five-year period, and numbers of cases showed a steady increase with time. Even though the number of newly diagnosed cases of leukemia in the study area was elevated, the number of deaths was not high.

None of the children with leukemia lived in proximity to any of the other children. Most of them lived in the Middle Country School District, which makes up most of the study area. About half of the children with leukemia were diagnosed in the last year of the study, 2015.

None of the cases of the chronic leukemias CLL and CML were reported by specialty physician practices on their own initiative (i.e. without being contacted to follow back on laboratory reports). There was a greater proportion of chronic leukemia cases reported by laboratories only in the study area and in Suffolk County compared to New York State excluding New York City.

Behavioral, Lifestyle, and Medical Care Utilization Characteristics

Tobacco Use

Lung cancer and bladder cancer are both tobacco-related. To gain information on whether tobacco-use habits in the CFS study area differ from the comparison area, data on tobacco use and smoking status were examined based on data from two sources: the Behavioral Risk Factor Surveillance System (BRFSS) and the Statewide Planning and Resource Cooperative System (SPARCS), which contains hospital inpatient and outpatient discharge data. (See Appendix 1 for a more complete description of each.)

The BRFSS is a statewide telephone survey of a random sample of state residents, and the enhanced version of this survey, the eBRFSS, was designed to obtain stable estimates of respondent behaviors on the county level. Because the CFS study area is much smaller than Suffolk County, data from two different survey years were merged to increase sample size. The BRFSS and eBRFSS do not collect respondents' street addresses, so the CFS study area was approximated as ZIP Codes 11720, 11738 and 11784. The proportions of the population in the Centereach/Farmingville/Selden study area, Suffolk County and New York State excluding New York City, who were current smokers are summarized in Table 13.

Table 13. Percent current smokers, persons age 18 and over, Centereach/Farmingville/Selden study area compared with Suffolk County and New York State excluding New York City

Area	%	95% CI
CFS study area*	27.3	12.5, 42.1
Suffolk County	16.1	13.2, 19.0
NYS excl. NYC	16.7	16.0, 17.4

Source of data: 2013-2014 eBRFSS and 2016 BRFSS
*approximated as ZIP Codes 11720, 11738 and 11784

- The results suggest that the percent of CFS area residents age 18 and older who were current smokers is greater than in the other comparison areas. Due to the relatively few CFS residents surveyed, however, confidence intervals around this estimate are wide, and the possibility that the difference was due to sampling variation cannot be excluded.

Hospital discharge data (SPARCS) contain various items that may be used as indicators of tobacco use among patients. The data include people admitted as inpatients as well as people visiting hospital outpatient and ambulatory surgery departments. Indicators of tobacco use include history of tobacco use, tobacco use disorder, toxic effect of tobacco, nicotine dependence, and smoking cessation; the most common indicators were history of tobacco use and tobacco use disorder/nicotine dependence. Table 14 shows the number of admissions and visits with these indicators per 100 population for unique individuals with home addresses in the CFS area and two comparison areas over the five-year period 2011-2015. Results are presented for all persons age 18 and over, and by broad age group. Additional findings may be found in Appendix 2, Table 3a-1.

Table 14. Tobacco use indicators by broad age group in persons admitted to or visiting a hospital per 100 population*, 2011-2015, Centereach/Farmingville/Selden study area compared with Suffolk County and New York State excluding New York City

Age group (years)	CFS study area		Suffolk County		NYS excl. NYC	
	Rate per 100 population	95% CI[1]	Rate per 100 population	95% CI[1]	Rate per 100 population	95% CI[1]
18 +	23.9	23.6, 24.3	19.9	19.8, 19.9	21.2	21.1, 21.2
18-49	18.8	18.3, 19.2	14.5	14.4, 14.6	17.5	17.5, 17.5
50-64	26.4	25.6, 27.1	21.6	21.5, 21.8	21.7	21.7,21.8
65 +	41.4	40.2, 42.5	34.1	33.9, 34.3	31.1	30.0, 31.1

Source of data: New York Statewide Planning and Research Cooperative System (SPARCS)
*2010 US Census
[1]95% confidence interval

- The rate of hospital admissions or visits with a tobacco-related indicator for persons living in the CFS study area was greater than the rate for persons in Suffolk County or New York State excluding New York City, in all age groups.
- The difference was particularly marked for persons age 65 and above.

Many other types of cancer have been associated with tobacco use. Along with lung cancer, it has been estimated that over half of cases of cancers of the mouth and throat, larynx and esophagus are caused by cigarette smoking or other use of tobacco. As a more indirect indicator of tobacco use in the study area, we also examined the incidence of other tobacco-related cancers. Appendix 4 Table 1 shows observed and expected numbers of cases of the 23 most frequently diagnosed types of cancer, including the types of interest in the present study, in the Centereach/Farmingville/Selden study area. This table shows that the number of cases of cancers of the mouth and throat (oral cavity) in the study area was also significantly above expected. Numbers of cases of esophageal cancer and laryngeal cancer were above the numbers expected, although the differences for these cancers were not statistically significant and could have occurred by chance. Of the other cancers that have been less strongly associated with tobacco use, there were statistically significant excesses in numbers of cases of pancreatic, cervical, and kidney cancers as well as bladder cancer. Numbers of cases of stomach, colorectal, and liver cancers, which have also been associated with use of tobacco, were not significantly elevated.

Obesity

Thyroid cancer has been associated with obesity, although the increase in risk of thyroid cancer in people who are obese is modest. To gain information on whether people in the Centereach/Farmingville/Selden study area may be more likely to be obese than in the comparison population, data from the pooled BRFSS surveys were examined. Table 15 compares the percent of the population that was obese for the ZIP Codes approximating the Centereach/Farmingville/Selden study area and two comparison areas. A table comparing the percent who were obese and the percent who were overweight or obese in the

Centereach/Farmingville/Selden study area and two comparison areas may be found in Appendix 2 Table 3b-1.

- The results suggest that the percent of CFS area residents age 18 and older who were obese is greater than in the other comparison areas. Due to the relatively few CFS residents surveyed, however, confidence intervals around this estimate are wide, and the possibility that the difference was due to sampling variation cannot be excluded.

Table 15. Percent obese, persons age 18 and over, Centereach/Farmingville/Selden study area compared with Suffolk County and New York State excluding New York City

Area	Percent	95% CI
CFS study area*	44.5	26.2, 62.8
Suffolk County	27.1	23.4, 30.8
NYS excl. NYC	27.2	26.4, 28.0

Source of data: 2013-2014 eBRFSS and 2016 BRFSS
*approximated by ZIP Codes 11720, 11738 and 11784

Data on indicators of obesity for hospital inpatient admissions and outpatient visits were also examined. Indicators of obesity included diagnoses of obesity and a body mass index (BMI, computed as weight in kilograms divided by the square of height in meters) of 30 or higher. Table 16 shows indicators of obesity by age group for the CFS study area and two comparison areas. Additional findings may be found in Appendix 2, Table 3b-2.

Table 16. Obesity indicators by broad age group in persons admitted to or visiting a hospital per 100 population*, 2011-2015, Centereach/Farmingville/Selden study area compared with Suffolk County and New York State excluding New York City

Age group (years)	CFS study area		Suffolk County		NYS excl. NYC	
	Rate per 100 population	95% CI[1]	Rate per 100 population	95% CI[1]	Rate per 100 population	95% CI[1]
21 +	9.6	9.3, 9.9	7.6	7.5, 7.6	8.0	8.0, 8.1
21-49	6.7	6.4, 7.0	5.2	5.2, 5.3	5.8	5.8, 5.9
50-64	12.2	11.6, 12.8	9.5	9.4, 9.6	9.8	9.8, 9.9
65 +	16.1	15.3, 17.0	11.5	11.4, 11.7	11.2	11.2, 11.3

Source of data: New York Statewide Planning and Research Cooperative System (SPARCS)
[1]95% confidence interval
*2010 US Census

- The Centereach/Farmingville/Selden study area has a slightly greater percentage of persons visiting the hospital who were noted as being obese compared to New York State excluding New York City, and to Suffolk County as a whole.
- This difference is greatest in the two older age groups.

Cancers other than thyroid that have been associated with obesity include one of the major types of esophageal cancer, colorectal cancer, pancreatic cancer, kidney cancer, and, in women, post-menopausal breast cancer and endometrial (uterine corpus) cancer. Appendix 4 Table 1 shows that there were statistically significant elevations in the study area in some of the other cancers associated with obesity, including pancreatic and kidney cancers, but not in others.

Access to Health Care

Contact with the health care system can influence the likelihood that someone could be diagnosed with certain cancers, such as thyroid cancer or chronic leukemias, before any symptoms appear. The BRFSS contains a question on whether the respondent has health care coverage, such as health insurance, an HMO, or government plans. People with health care coverage can more easily access health care services, but the extent of contact with the health care system may differ even between areas with the same level of health care coverage. The question on health care coverage can be used to assess access to medical care and potential contact with the health care system in people under age 65. (Nearly all people age 65 and older are covered by Medicare.) The percentages of respondents age 18-64 reporting health care coverage in the Centereach/Farmingville/Selden study area and two comparison areas, Suffolk County and New York State excluding New York City, are shown in Table 17.

Table 17. Percent of persons age 18-64 with health care coverage, Centereach/Farmingville/Selden study area compared with Suffolk County and New York State excluding New York City

Area	Percent	95% CI
CFS study area*	94.1	87.3, 100.9
Suffolk County	86.8	83.4, 90.2
NYS excl. NYC	88.3	87.5, 89.1

Source of data: 2013-2014 eBRFSS and 2016 BRFSS
*approximated by ZIP Codes 11720, 11738 and 11784

- The results suggest that the percent of CFS area residents age 18-64 who had health care coverage is greater than in the other comparison areas. Due to the relatively few CFS residents surveyed, however, confidence intervals around this estimate are wide, and the possibility that the difference was due to sampling variation cannot be excluded.

Occupational Factors

- Lung and bladder cancers and certain types of leukemia have been associated with various exposures in the workplace. Data from the American Community Survey on the occupations and industry of employed persons age 16 and over in the study area and the comparison areas were therefore reviewed. Table 18 below shows the breakdown of the civilian employed population age 16 and older into a group of occupations with a higher probability of workplace exposures to elevated levels of hazardous substances and all others. Figures are provided for New York State, New York State excluding New York City, Suffolk County, and the 15 census tracts that include the study area. Finer groupings of occupations and tabulations by individual census tract in the study area may be found in Appendix 2 Table 3c-1. A breakdown by industrial category may be found in Appendix 2, table 3c-2. The CFS study area, along with New York State excluding New York City and Suffolk County, had a slightly greater proportion of persons working in production, construction, transportation and firefighting occupations considered together than New York State as a whole.

- When broken out by categories within this group (see appendix), the CFS study area had slightly more people working in construction and extraction occupations; installation, maintenance and repair; and transportation. There were slightly fewer people working in production occupations. These percentages are based on small numbers of respondents, especially in the study area, and may not be meaningful.

Table 18. Percent of the population in selected occupational groups, civilian employed population age 16 and over, 2011-2015, New York State, New York State Excluding New York City, Suffolk County, and the Centereach/Farmingville/Selden study area

	NYS	NYS excl. NYC	Suffolk Co.	CFS study area*
	Percent	Percent	Percent	Percent
Groups with higher probabilities of workplace exposures[1]	18.27	19.52	20.32	20.36
All other occupations	81.73	80.48	79.68	79.64

Source of data: US Census American Community Survey 2011-2015, table S2401: OCCUPATION BY SEX FOR THE CIVILIAN EMPLOYED POPULATION 16 YEARS AND OVER

[1]Includes occupations in the US Census categories Natural resources, construction, and maintenance occupations; Production, transportation and material moving occupations; and firefighters.

*Data are for 15 entire census tracts, including block groups that are not in the study area

World Trade Center Exposures

Community members and medical professionals have reported that many persons who were first responders to the World Trade Center attacks in New York City on September 11, 2001 live in the Centereach/Farmingville/Selden study area. The occurrence of cancers has been studied in three groups of World Trade Center first responders and rescue and recovery workers: firefighters followed by the Fire Department of New York, rescue and recovery workers studied by the New York City Department of Health and Mental Hygiene, and rescue and recovery workers monitored by the World Trade Center Health Consortium at Mount Sinai Hospital. These groups are largely male (81-100%) and had a median age at the time of the attacks ranging from 38 to 44. Researchers found two- to three-fold excesses of thyroid cancer and up to a 50% excess in prostate cancer in all three groups when followed through 2008. Numbers of cases of lung cancer were lower than expected, and none of the groups showed significant excesses in numbers of cases of bladder cancer or leukemia[1]. The excess in thyroid cancer persisted when the follow-up period was extended to 2011, ten years after the attacks, for the group monitored by the New York City Department of Health and Mental Hygiene[2]. 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.

Data from the American Community Survey show a slightly higher percentage of people who were firefighters and law enforcement personnel in the census tracts approximating the study area compared to the other areas, but these estimates are based on small numbers and the margin of error is wide. Census data also do not specify the department where the respondents worked. Stony Brook University Hospital, located just outside the CFS study area, conducts medical monitoring of rescue and recovery workers who worked at the World Trade Center site for the World Trade Center Health Consortium. The proximity of this facility to the CFS study area is likely an indication of the demand for these services in the general vicinity, and it is likely that many of the workers followed by the consortium live in the study area.

Environmental Data Review

Outdoor Air Quality

Air Quality Monitored Data

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 (EPA) 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.

The following data sources were used in this evaluation to provide indicators of current and historical air quality in the CFS study area as well as in NYS more generally:
1) The US Environmental Protection Agency's (EPA's) Air Quality System database,
2) EPA's National-scale Air Toxics Assessment (NATA) data.

The EPA's **Air Quality System** database contains data from air quality monitoring stations across New York State at various locations and timeframes since 1965. This database currently includes sulfur dioxide, ozone, carbon monoxide, nitrogen dioxide, lead, total suspended particulates, and particulate matter less than 2.5 and 10 microns (PM2.5 & PM10) 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. For the NATA program, EPA estimates chemical-specific air concentrations for small geographic areas known as census tracts across the US (https://www.epa.gov/national-air-toxics-assessment). The number of EPA-designated HAPs included in the model has varied from 32 in 1996 to 180 plus diesel particulate matter in 2014. 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 (see Appendix 1). EPA 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. EPA also accounted for secondary formation of pollutants through photochemical mechanisms and pollution due to residential wood burning, wildfires, agricultural burning, and structural fires.

The criteria air pollutants database provides the longest history of air pollution measurements in New York State. A few monitoring stations operated throughout the years in or adjacent to the study area. The monitoring trends for nitrogen dioxide, sulfur dioxide and carbon monoxide can be found in Appendix 3A Figures 1-3. Criteria air pollutant concentrations have decreased substantially over time as illustrated in the graphs, and currently this region complies with EPA National Ambient Air Quality Standards (NAAQS) for all criteria pollutants, except for ozone (not shown). Information about ozone has not been presented in this report for a number of reasons. Ozone is not a carcinogen and 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. The primary NAAQS are health-based, but the levels are not specifically based on the risk of developing cancer. More information on criteria pollutants can be found online at https://www.epa.gov/criteria-air-pollutants.

DEC operated an air toxics monitoring station in Holtsville, just south of the CFS study area, for a limited amount of time, approximately eight years. Figures 1 through 3 in Appendix 3B present the trends in measured concentrations of benzene, 1,3-butadiene, and carbon tetrachloride at the Holtsville station along with a brief toxicological and contextual summary. For some data points in this figure, DOH calculated annual average concentrations although criteria pertaining to a full year's representation for a dataset were not met. All air toxics presented, with the exception of carbon tetrachloride, are predominantly from mobile sources. Although the air toxic concentrations are higher than DEC's annual guideline concentrations (AGC) for benzene, 1,3-butadiene, and carbon tetrachloride, this pattern is not unique to these monitors. Similar patterns can be observed for other monitoring locations across New York State. Therefore, exposures to these concentrations are not unique to the study area and Suffolk County.

Modeled Data: National-scale Air Toxics Assessment (NATA)

DOH researchers used the NATA modeled estimates for 2011 to 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 compared to other comparison areas of New York State. The comparison areas and metrics used for this evaluation include the average risks for Suffolk County, New York State, and New York State excluding New York City. 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 in a population of one-million (or a one-in-one-million cancer risk). This resulted in the 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. It should be noted that a direct comparison of the cancer risk estimates in 2014 relative to 2011 needs to be interpreted with caution due to changes in the air modeling and emissions inventory.

Table 19 shows the risk estimates and the comparison ratios for the five pollutants included in the evaluation for NATA 2011. Table 20 shows the same information for NATA 2014. These tables demonstrate that, with some small differences, the estimated inhalation cancer risks for

Table 19. NATA 2011 comparison ratios and risk estimates, Centereach/Farmingville/Selden study area, Suffolk County, New York State Excluding New York City, and New York State

Pollutant	Comparison Ratios			Total Cancer Risk (per million)			
	Study Area/ Suffolk County	Study Area/ NYS excl. NYC	Study Area/ NYS	CSF Study Area	Suffolk County	NYS excl. NYC	NYS
1,3-Butadiene	1.01	1.02	0.57	1.99	1.97	1.96	3.51
Acetaldehyde	1.01	0.96	0.76	3.18	3.15	3.31	4.2
Benzene	0.97	0.89	0.61	5.19	5.35	5.81	8.47
Carbon tetrachloride	1.00	1.00	1.00	3.28	3.28	3.28	3.28
Formaldehyde	1.02	1.02	0.76	15.60	15.32	15.26	20.51

Table 20. NATA 2014 comparison ratios and risk estimates, Centereach/Farmingville/Selden study area, Suffolk County, New York State Excluding New York City, and New York State

Pollutant	Comparison Ratios			Total Cancer Risk (per million)			
	Study Area/ Suffolk County	Study Area/ NYS excl. NYC	Study Area/ NYS	CSF Study Area	Suffolk County	NYS excl. NYC	NYS
1,3-Butadiene	1.08	1.21	0.62	1.15	1.06	0.95	1.85
Acetaldehyde	1.01	0.94	0.78	1.64	1.62	1.75	2.11
Benzene	1.04	1.05	0.74	3.69	3.56	3.52	4.96
Carbon tetrachloride	1.00	1.01	1.00	3.30	3.30	3.28	3.29
Formaldehyde	1.02	1.02	0.82	12.79	12.54	12.49	15.55

the study area are generally similar to those estimated risks for Suffolk County and New York State excluding New York City but are lower than for the entire state. The estimated cancer risk associated with these HAPs does not appear to be differentially impacting this study area. None of the ratios were substantially elevated in the CFS study area, indicating it would be difficult to determine an additional cancer burden for both modeling years.

Summary

This area has experienced considerable residential and commercial growth in the last decades but is not a highly-industrialized area. The increase in number of residences has been accompanied by the development of a dense network of highways and local roads. The enactment of Federal and State regulatory actions under the Clean Air Act and its Amendments has drastically improved air quality across the state, as evident in Appendix 3A, Figures 1-3, which show decreasing trends of criteria pollutant concentrations in the study area. Currently, the study area is in attainment for the NAAQS for all criteria pollutants, with the exception of ozone (not shown). Because of the limited air toxics monitoring information in the study area, we are unable to say anything about historical exposures to air toxic pollutant concentrations. Toxicological information for the air toxics graphed and evaluated in NATA is provided in Appendix 3B, Figures 1-3.

The available air quality monitoring and modeling data do not suggest that people living in the CFS study area are currently exposed to unusual levels of air pollution. DOH researchers estimate that inhalation exposure over a lifetime to the chemicals evaluated pose a “low” risk of cancer. In this context, “low” is used to describe an estimated excess lifetime cancer risk (probability) of one-in-ten-thousand or less. This level of cancer risk is small compared to the background rate of cancer and would not be detected in an epidemiologic study. The cancer risk estimate is a theoretical estimate and does not estimate the risk for any individual or group of people.

Limitations for Outdoor Air Quality Evaluation

There are significant limitations to this analysis of outdoor air quality indicators as risk factors for cancer. Although everyone is exposed to chemicals in the air, it is not possible to fully characterize people’s individual inhalation exposures to chemicals through activities such as smoking, use of consumer products, occupational exposures and hobbies. In this analysis, we focused on expected “risk drivers” (*i.e.*, those chemicals that contribute most to the estimated inhalation risk) rather than every EPA-designated hazardous air pollutant that contributes minimally to the overall estimated inhalation risk. Comprehensive information on historical outdoor air concentrations that could be relevant to cancer due to latency considerations is also lacking.

Radon in Indoor Air

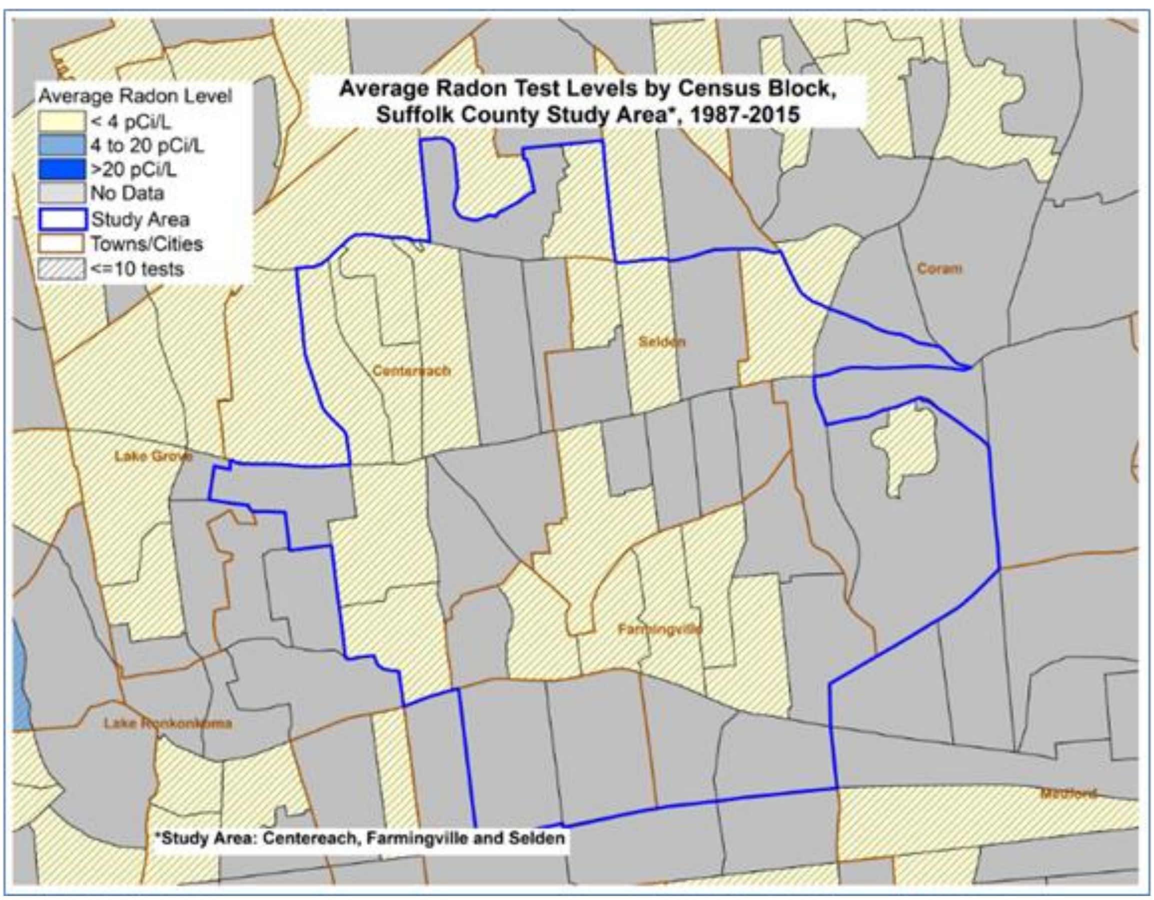
Results

From 1987 to 2015, there were 153,765 valid tests (values at or above the laboratory's lowest detection level of 0.17 pCi/L) conducted in homes and schools across New York State. The statewide average radon test value was observed at 5.53 pCi/L with 64% of the tests performed in the basement, 32% in the first floor living area and 4% in other or unknown floors.

Table 21. Radon tests in the study and comparison areas from 1987 to 2015

Area	Mean Concentration (pCi/L)			Max Concentration (pCi/L)	% test results ≥ 4 pCi/L
	All floors (N)	Basement (N)	First Floor (N)		
CFS Study Area	0.98 (23)	1.31 (13)	0.55 (10)	5.8	4.35%
Suffolk County	1.54 (914)	1.8 (617)	0.98 (297)	42.6	5.47%
NYC	1.62 (2,269)	1.69 (1,739)	1.38 (530)	146.7	6.74%
NYS excl. NYC	6.7 (129,645)	7.06 (89,701)	3.85 (39,944)	601.4	34.30%
NYS	5.99 (131,914)	6.96 (91,440)	3.81 (40,474)	601.4	33.83%

Figure 11. Radon concentrations measured in the study area



For the most accurate reading of radon levels in a home, tests are conducted in the lowest living space, generally the basement or first floor of the building. Results in this report reflect the values of 131,914 radon tests conducted in the basement and first floors in study and comparison regions (excluding tests performed at schools and day care centers). About a third of these tests had values at or exceeding the action level of 4 pCi/L. Two thirds of the tests were conducted in the basement where radon test levels averaged at 6.96 pCi/L with a maximum of 601.4 pCi/L. Statewide radon values for first floor tests averaged 3.81 pCi/L with a maximum value of 259.5 pCi/L.

Twenty-three tests were conducted in the CFS study area from 1987-2015. The average radon concentration was 0.98 pCi/L (range 0.2 to 5.8), with 4.4% of tests with values at or higher than the EPA action level of 4 pCi/L. About 57% of CFS tests were conducted in the basement, with an average radon concentration of 1.31 pCi/L (maximum test value 5.8), while the average radon level among first floor tests was 0.55 pCi/L (maximum test value 2.3). Average radon concentrations in this study area (overall, basement and first floor levels) were lower than Suffolk County, NYC and Statewide levels. Average radon concentrations for Suffolk County were 1.54 pCi/L (range: 0.2 to 42.6) and about 5.5% of basement tests showed levels at or higher than the EPA action level (See Figure 11 and Table 21).

Summary for Radon in Indoor Air

Based on test results in the database, it appears that radon is not a significant environmental exposure in the CFS study area. Radon test levels were observed to be generally lower than comparison areas and statewide results.

Drinking Water

Public Drinking Water Supply

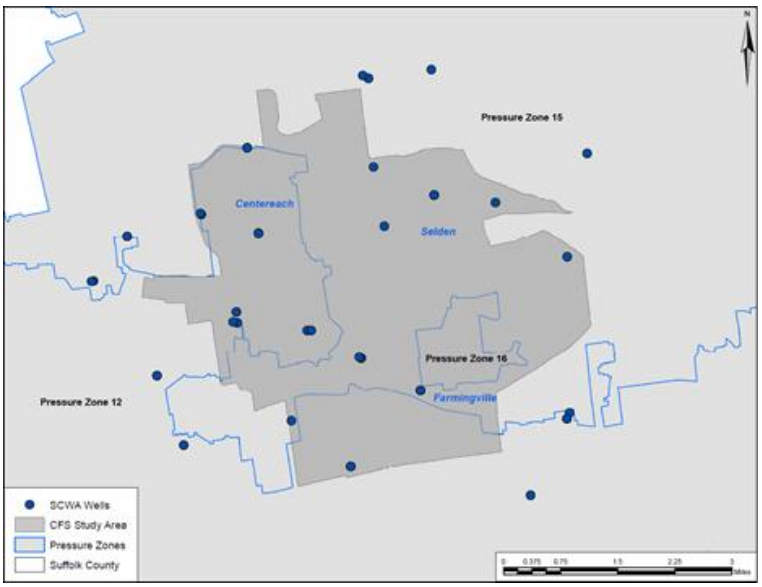
The CFS study area is in the heart of Suffolk county, and public drinking water is provided by the Suffolk County Water Authority (SCWA). SCWA is Suffolk County's largest provider of community public drinking water, producing 200 million gallons of drinking water per day for a system population of over 1,137,000. In the 1970s and 1980s, several smaller public water suppliers offered service to small areas, including community and non-community drinking water. However, the SCWA now services these areas.

The SCWA supplies its customers through a network of groundwater wells. In total, 628 wells are situated throughout the SCWA's service area. Thirty-four of these wells are within the CFS study area, with an additional 19 wells within one mile of the study area boundary. These 53 wells are in three different service areas, called pressure zones. Pressure zones are portions of the water distribution system that are under separate control mechanisms.

A large majority of the CFS study area is in Pressure Zone 15, which includes 23 of the 53 wells. Pressure Zone 12 comprises a portion of the western boundary and all of the southern end of the study area, containing the remaining wells. Additionally, Pressure Zone 16 is located entirely within the study area, near the southeast border, yet no wells are located within this zone. This zone acts as a pressure booster for Zone 15.

Public drinking water is provided by operating multiple facilities in response to distribution system water pressure or by timed delivery by pumping systems. Wells are not all in use at any given time, but are brought into production based on consumer use, maintenance needs, and in some cases, active roles in eliminating the entry of contaminants into the distribution system. Although specific wells tend to be used for individual pressure zones, water can be exchanged across pressure zone boundaries depending on operational pressure and demands on the system, as is the case with Zone 16. This can be seen in Figure 12.

Figure 12. Wells and pressure zones within the Centereach, Farmingville, Selden study area

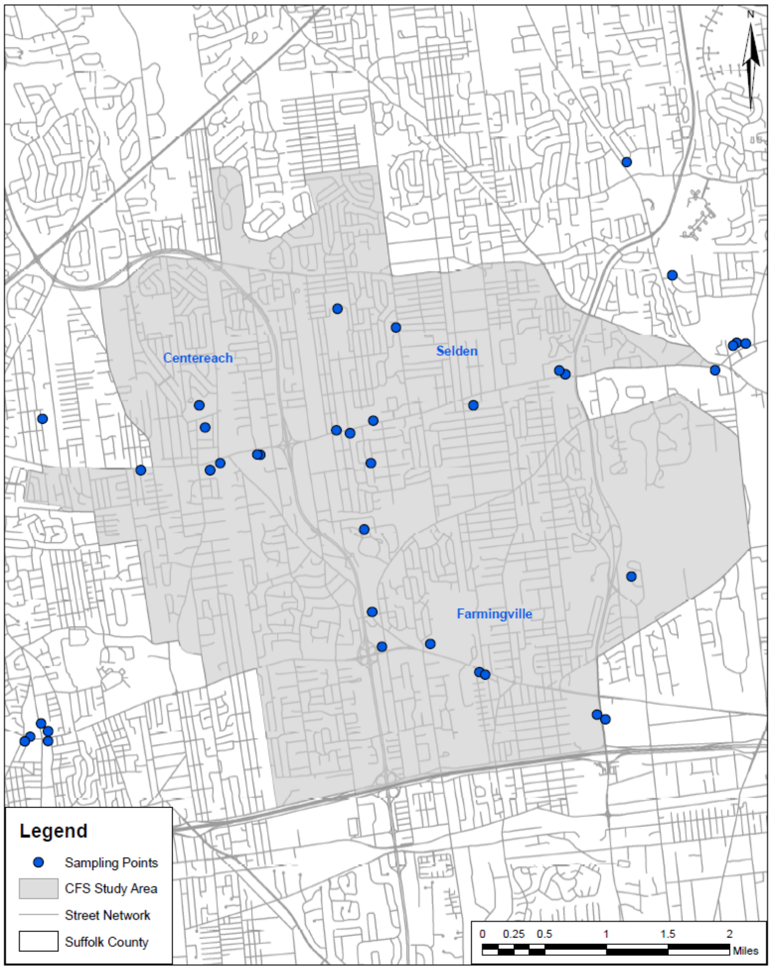


Public water systems are required to routinely test for contaminants in drinking water. Sampling in Suffolk County is done by testing at various points within the distribution system, such as water from restaurant kitchen sinks or bathrooms. In total, since 1999, over 120,000 water samples were taken from 37 points for this study area (see Figure 13).

The SCWA has a history of proactively meeting DOH and federal standards for what constitutes safe drinking water. SCWA monitors for water contaminants more frequently than DOH or the federal government requires. The monitoring results are used to manage each water supply well and apply necessary treatment to comply with drinking water standards. Appendix 3C, Table 1 provides a list of the analytes that are evaluated.

For most regulated analytes, if sampling reveals an exceedance of a maximum contaminant level (MCL), a violation is issued. The pubic water system is then required to make public

Figure 13. Public water system sample locations in the Centereach, Farmingville, Selden study area



notification of the violation and take steps to reduce the contaminant level below the MCL. For lead and copper, a different regulatory limit applies and is called an action level.

For this evaluation, staff reviewed testing results for analytes that were detected at levels higher than the respective MCLs or action levels and focused primarily on the subset of tests that led to violations being issued. For the CFS study area, the only violations issued for SCWA drinking water were for primary inorganic compounds (PICs) and lead and copper (PBCU), as described below.

Primary Inorganic Compounds (PICs). The EPA established non-enforceable “secondary” MCLs for iron at 0.3 mg/L and for manganese at 0.05 mg/L. These levels represent concentrations of iron and manganese that can affect taste and stain clothing and dishes, but these levels are not related to health risk. There were 57 exceedances of these iron and iron+manganese MCLs since 1999, representing less than one percent of all PIC samples.

Although iron is essential for good health, too much iron can cause adverse health effects. For example, oral exposure to high levels of iron can cause effects on the stomach and intestines (nausea, vomiting, stomach cramps, and diarrhea). These effects occur at iron exposure levels higher than those typically found in drinking water and usually diminish once exposure is

stopped. Manganese is an essential nutrient that is necessary to maintain good health. However, exposure to too much manganese can cause adverse health effects. There is some evidence from human studies that long term exposure to high levels of manganese is associated with nervous system effects in adults (weakness, stiff muscles, and trembling of the hands) and children (learning and behavior). As stated above, these compounds were detected in some samples at levels above the MCLs that are based on taste, odor, and appearance. These compounds were measured at concentrations that are lower than concentrations associated with health effects in humans. The MCL exceedances for PICs are presented in Appendix 3C, Table 2.

Lead & Copper (PBCU). Lead and copper were the only other analytes detected in exceedance of the action level in SCWA's drinking water since 1999. In total, there were four exceedances within the CFS study area, which accounts for less than one percent of all samples taken. Three of these exceedances were a result of elevated lead levels and one was an elevated level of copper. Results are shown in Appendix 3C, Table 3.

While copper is needed for good health, exposure to too much copper can lead to adverse health effects. Drinking water with high levels of copper causes short-term gastrointestinal effects in humans, including nausea, vomiting, diarrhea, and abdominal pain. These effects are typically reversible and diminish once exposure to elevated copper levels is stopped.
Young children, infants, and fetuses are particularly vulnerable to lead, and exposure is associated with nervous system effects, developmental delays, and behavior and learning problems. In adults, exposure to lead is associated with cardiovascular effects, reproductive effects, and kidney effects. There are many sources of lead exposure in the environment, and it is important to reduce all lead exposures as much as possible.

In the general population, human drinking water exposure to iron, manganese, or copper has not been associated with increased cancer risk. The US EPA concludes that there is sufficient evidence of carcinogenicity of lead in laboratory animals exposed to high levels over their lifetimes. Whether or not human exposure to lead increases cancer risk is unknown.

Unregulated Contaminants

EPA'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.

EPA's Third Unregulated Contaminant Monitoring Rule (UCMR 3) occurred between 2013 and 2015. The list of UCMR 3 contaminants can be found in Appendix 3C, Table 4. The UCMR 3 contaminants detected in the public water system serving the CFS study area were all below EPA reference levels provided in EPA's UCMR 3: Data Summary, January 2017[14]. EPA's reference concentrations provide context but do not represent an "action level". Reference concentrations are health guidelines estimated from animal studies with a level of uncertainty built in.

Private Wells in CFS Study Area

Suffolk County Water Authority provides most residents in the CFS study area with their drinking water; private wells are estimated to serve approximately 2% of study area households. Private well water quality is generally not regulated under state or federal programs. The Suffolk County Department of Health Services operates a private well water testing program and there are data available from as far back as 1997 for some private wells in the study area. While not comprehensive for all private wells, the available data were reviewed for this investigation and findings from this review are presented in Appendix 3D, Tables 1-4. Overall, private water sources tested in the CFS study area have generally met drinking water standards, with very few instances of results exceeding an MCL or action level.

Limitations

As stated in the introduction, data utilized in this study were collected for purposes ranging from routine monitoring to special investigations. The data were not collected solely for the purpose of evaluating drinking water in association with cancer risk.

Summary for Drinking Water

The CFS study area is entirely served by the Suffolk County Water Authority, which supplies drinking water through a network of groundwater wells. There were very few analyte exceedances in the CFS study area. Exceedances occurred for two analyte groups, primary inorganic compounds (PICs), and lead and copper (PBCU).

The PIC exceedances were for iron and iron+manganese. The MCL concentrations for these analytes are set at levels based on aesthetic qualities such as taste and color. The MCL concentrations are lower than concentrations associated with health effects in humans. The other exceedances were for lead and copper. Lead was detected above the action level three times and copper once over a 19-year timeframe. When a public water system receives an MCL violation, the public receiving that water must be made aware, and the water supply must take corrective actions required by EPA or the DOH to return to compliance. Available data indicate that water sourced from private wells has also been of high quality, with exceedances of MCLs and action levels being relatively infrequent.

Industrial and Inactive Hazardous Waste Disposal Sites

Based on a review of available information, there are no industrial or inactive hazardous waste disposal sites located within the boundaries of the CFS study area. Residents have, however, raised concerns about the Northville pipeline and about a gasoline spill at the Northville Terminal in East Setauket. The Northville pipeline, which runs through the CFS study area, is discussed below. Information about the spill, which occurred outside of the study area, is provided in Appendix 4.

Northville Pipeline

Northville maintains and operates a pipeline system which connects the Port Jefferson Marine Dock, the Setauket Terminal on Belle Mead Road and the Holtsville Terminal on Union Avenue. This pipeline runs through a portion of the CFS study area (through Centereach and along the east edge of Farmingville).

The Northville pipeline receives product (gasoline, diesel, #2 fuel oil and ethanol) from barges through two 16" diameter pipelines that run side-by-side between Port Jefferson Harbor and the Setauket terminal for approximately 2.84 miles underground. There is a third pipeline nestled alongside the other two, but it has been cleaned and placed out of service. Once product reaches the Setauket terminal, it can be stored on site or transferred to a 12" diameter pipeline that runs from the Setauket terminal to the Holtsville terminal along public and Long Island Power Authority (LIPA) right-of-ways for approximately 8.34 miles.

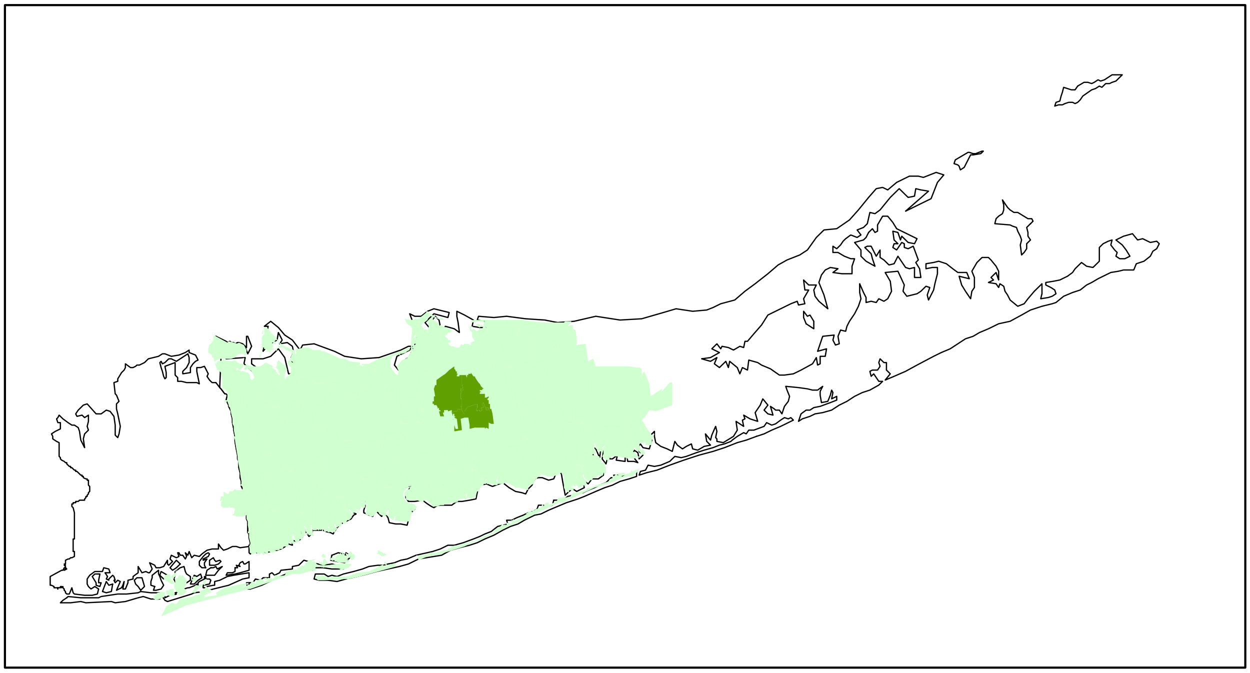
All of the pipelines are buried fairly deep (in the range of 10-15 feet or more below grade), routinely undergo structural integrity inspections and tightness testing, are protected from corrosion, and are constantly monitored for leaks. The terminals are licensed by DEC, but the pipelines fall under federal regulations. DOH has authority to require actions should a pipeline leak. The pipelines are fully enclosed and no product is released. Therefore, there is no known human exposure to any product being transferred through the pipelines.

Commercial Pesticide Sales and Use

Results

DOH researchers used the available data on commercial pesticide applications to assess whether unusual patterns exist in the CFS study area. The New York State Pesticide Reporting Law enacted in 1996 requires that commercial applicators maintain a record of each pesticide application made. The record includes the street address and county of the application, the EPA Registration number and the quantity, in pounds or gallons, for each product applied. The data are entered into a database that is publicly available at the ZIP Code and county level on the Pesticide Sales and Use Reporting (PSUR) webpage maintained by the Cornell University Cooperative Extension. Commercial pesticide sales and application data are currently available for the years 1997 through 2016. It is important to note that applications of pesticides by property owners are not captured in this database and that these types of applications may be greater in number than commercial applications. Pesticide application data for the three ZIP Codes (11720, 11738, 11784) that approximate the area of interest were compared to data for an area in Suffolk County running from the eastern border of the Town of Brookhaven west to the Nassau County border (Figure 14).

Figure 14. Commercial pesticide application data for the ZIP code area (encompassing CFS study area) and comparison area.



The graphical results of the data analysis are presented in Appendix 3E, Figures 1 through 8.

Staff gathered information about the total pounds or gallons of each product as well as the specific pesticides and active ingredients in the products so that quantities of each active ingredient applied over the fourteen-year period 2000-2013 could be estimated. 2010 Census data and geographic information system software were used to estimate land area and the total number of households so that active ingredient quantities could be expressed per square mile and per household. Additional information about pesticide data, methods, and limitations can be found in Appendix 1.

The data evaluation shows that commercial pesticide applications in the ZIP Code area were smaller in quantity per square mile and per household than in the comparison area for the years examined. With one exception (boric acid), all the active ingredients commercially applied in solid form were contained in products marketed for lawn care, as noted in the descriptions of each active ingredient in Appendix 3E. The relative quantities of active ingredients applied in the two areas over the time period examined are similar with one exception, the active ingredient trichlorfon, an insecticide, which comprised a much smaller percentage (2 percent) of active ingredient applied in the ZIP Code area compared to the comparison area (19 percent). Nearly all the active ingredients commercially applied in the areas examined were contained in products marketed to keep lawns green and free from weeds and insects. This evaluation of commercial pesticide applications indicates that the quantities and types of such pesticide applications are not unusual in the study area compared to the surrounding area.

Limitations

There are many limitations associated with use of the PSUR data in this way to estimate potential human exposures. The PSUR database does not include pesticide applications by property owners or household members themselves, so it is not possible to make any definitive statements about the total quantities of pesticides applied or rates of application. Normalizing the data by land area assumes that land use is similar in both the ZIP Code area and the comparison area, which may not be the case. Differences in land use may be a factor in the differences observed in the relative quantities of some of the active ingredients applied, shown in Appendix 3E, Figures 5 through 8. The household density in the ZIP Code area is 40 percent greater than in the comparison area. This means that even if the quantities of active ingredients applied per square mile are the same for both areas, the quantities applied per household will be lower for the ZIP Code area since there are more households per square mile than in the comparison area. The evaluation did not consider exposure scenarios for different types of pesticide products to determine if some may have greater exposure potential than others.

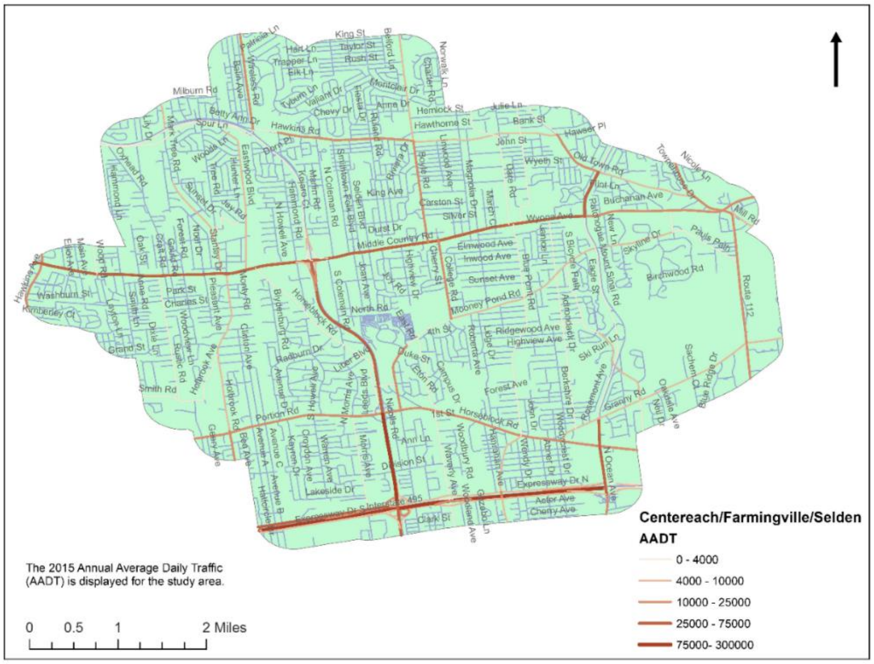
Other Environmental Concerns – Traffic Density

The most heavily trafficked road in the study area is the Long Island Expressway, which forms the southern boundary of the study area. Staff looked at the proportion of people who live within 500 meters of roads with traffic counts in the study area. In the CFS study area, 5 percent of people live within 500 meters of roads with an annual average daily traffic (AADT) volume of 75,000-300,000 vehicles, 18 percent within 500 meters of roads with an AADT volume of 25,000-75,000 vehicles, and 76 percent live near roads with less AADT. In general, the study area had a similar distribution of people by proximity to road as NYS excluding NYC. 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 22 and Figure 15).

Table 22. Percent population living within 500 m of DOT monitored roads by annual average daily traffic volume

Area	75,000 - 300,000 AADT	25,000 - <75,000 AADT	<25,000 AADT
CFS Study Area	5%	18%	76%
NYS excluding NYC	5%	14%	81%
NYC	29%	30%	41%
NYS	15%	21%	64%

Figure 15. Map of Traffic Density for the CFS Study Area



Study 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.

With the conventional standard for statistical significance used in this study, approximately one out of every 20 statistical tests (5%) will be statistically significant due to chance alone. In this study, a large number of comparisons were made between expected and observed cancers for different subgroups, such as age groups and tumor subtypes. When many statistical tests are done, the probability is high that at least one statistically significant difference will occur entirely by chance.

When evaluating the possible contribution of environmental factors, it is important to consider exposure. Exposure is contact. For any substance to have an effect on human health, people have to be exposed to it. People may be exposed to a chemical substance by breathing it in (inhalation), consuming it in food or water (ingestion), or getting it on their skin (dermal exposure). Even with exposure, not all hazardous substances cause cancer. The risk of developing cancer upon exposure to a cancer-causing substance depends on the amount of the substance people are exposed to, the length of time they are exposed to it, and how often they are exposed to it.

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. As illustrated in the further evaluation of the diagnoses of chronic leukemias, variation in cancer incidence among different 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. 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].

Behavioral, Lifestyle, Medical Care Utilization

Information on smoking prevalence, obesity, and health insurance coverage was obtained from the Behavioral Risk Factor Surveillance System (BRFSS), a telephone survey of the New York State population. The survey was designed to sample an approximately equal number of people in each county, so that in the larger counties such as Suffolk, a smaller percentage of the population was contacted. This means that the sample size in a small area of the county such as the study area would be relatively small. In particular, for both survey years combined there were fewer than 50 people from the Centereach/Farmingville/Selden study area who were included in the survey, resulting in a wide margin of error (confidence interval). In regard to specific questions, smoking was assessed based on the percentage who were current smokers, while former smokers are also at increased risk of 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 sensitivity of the questions. There is no reason to believe, however, that any biases would operate any differently in the study area than in any other region.

Hospital inpatient and outpatient discharge data from the Statewide Planning and Research Cooperative System (SPARCS) were used as a second indicator of behavioral and lifestyle factors in the study area. Hospital discharge data were created for administrative purposes and have limitations when used for research. In particular, they pertain only to persons admitted to or visiting the hospital, who are probably not representative of the population at large. Patterns of hospital inpatient and outpatient utilization may differ in different parts of the state, so any differences between areas could in part be a result of differences in patterns of care. When the rates of total hospital admissions/visits per 100 population were computed (in persons age 50-64 and 65+) (see Appendix 2, Table 3a-1), overall utilization rates were similar for the CFS study area, New York State, New York State excluding New York City, and Suffolk County, meaning that residents of the different areas were equally likely to be admitted to or visit the hospital. However, there still may be differences in the likelihood of being admitted to or visiting a hospital facility for specific reasons.

Occupation

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 are frequently sparsely located and do not provide complete insight into 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 have not been developed specifically to evaluate human exposures to chemicals in the environment (*e.g.*, compliance/monitoring data and permit information). 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 will 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 information about an individual's historical patterns of personal 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. DOH researchers 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.

Interpretation

Lung Cancer

Screening people at high risk for lung cancer was first recommended on a population-wide basis in 2013. The introduction of screening to detect cancer at an early but cancerous stage will initially lead to an increase in the incidence of that cancer, as more cancers are detected. In the study area, the percent of cases diagnosed at an early stage was quite variable from year to year, likely due to the relatively small numbers of cases diagnosed at a particular stage in a single year, however the stage distribution over all five years was similar to that in the comparison area. If there were more cases detected by screening in the last two years of the study, it would likely not be possible to distinguish them from random variation. Screening is ultimately intended to reduce deaths from lung cancer, but any effect on lung cancer mortality might not be evident for a few years, as people whose cancers were detected early do not die from the disease when they would have otherwise. The elevated mortality from lung cancer seen in the CFS study area does not preclude increased screening after 2013.

Both survey data and hospital discharge data suggest that people living in the CFS study area may be more likely to use tobacco than the average for the comparison populations. Several other tobacco-related cancers were diagnosed in greater than expected numbers in the study area. Many of these cancers have important risk factors other than tobacco use that may be contributing to the higher numbers, so this evidence should be interpreted with caution. Despite the respective limitations of the different data sources, the fact that independent data point in the same direction supports the possibility that elevated tobacco use in the CFS study area may have contributed to the elevation in lung cancer.

Like New York State excluding New York City and Suffolk County, the study area has a greater proportion compared to New York State of people working in largely blue-collar occupations considered together, and of many blue-collar occupational groups, such as construction and extraction workers. Elevated exposures to various cancer-causing substances in the workplace are more likely to occur in these types of occupations, although the particular exposures would differ for different occupations and possibly even workplaces. People in blue-collar occupations, particularly construction workers, also are more likely to smoke[1]. The greater proportion employed in occupations with possible occupational exposures might account for a portion of the excess in cases compared with the New York State standard, but not when comparing the study area with New York State excluding New York City. There were insufficient data available to evaluate the possible contributions of specific occupations.

Radon has been estimated to be the second most important cause of lung cancer, after smoking. Data from home radon testing, however, indicate that radon concentrations in the study area were generally lower than in the comparison areas. Radon exposure thus does not appear to be contributing to the excess in lung cancer cases.

Specific air pollutants as well as urban air pollution in general have been associated with lung cancer. Air toxics monitoring in Holtsville, just south of the CFS area, showed levels of benzene, 1,3-butadiene and carbon tetrachloride that were above the AGC set by DEC to protect public health. Levels, however, were similar to other monitoring locations throughout New York State. Results of modeling air quality, based on emissions data, showed that levels of hazardous air pollutants in the study area were comparable to those for Suffolk County as a whole and New York State excluding New York City, and less that those for the state as a whole. The study area also had a similar distribution of people by proximity to road traffic as New York State excluding New York City. Available data on air quality do not indicate an unusual impact in the CFS study area.

Although exposure to most of the substances that have been associated with lung cancer occurs by inhalation, elevated lung cancer rates have also been seen in communities with high levels of arsenic in the drinking water. Routine testing of public water supplies includes testing for a wide variety of organic and inorganic substances, including arsenic. Results of water quality testing in the study area have not detected arsenic in either the municipal water supplied by the Suffolk County Water Authority, or in private wells. In public water, there were sporadic detections over 19 years of iron and iron+manganese (iron and manganese combined) at concentrations above maximum contaminant levels (MCLs) and of lead and copper above their respective action levels. Iron and manganese MCLs are set at levels based on taste, odor, and appearance. These MCLs and the maximum levels at which iron and manganese were measured in drinking water are lower than concentrations associated with health effects in humans. None of the substances detected at levels above the applicable standards in public or private drinking water has been associated with lung cancer.

Bladder Cancer

Both survey data and hospital discharge data suggest that people living in the CFS study area may be more likely to use tobacco than the average for the comparison populations. Several other tobacco-related cancers were diagnosed in greater than expected numbers in the study area. Many of these other cancers have important risk factors other than tobacco use that may be contributing to the higher numbers, so this evidence should be interpreted with caution. Despite the respective limitations of the different data sources, the fact that independent data point in the same direction supports the possibility that elevated tobacco use in the CFS study area may have contributed to the elevation in bladder cancer as well as lung cancer.

Like New York State excluding New York City and Suffolk County, the study area has a greater proportion compared to New York State of people working in largely blue-collar occupations considered together, and of many blue-collar occupational groups, such as construction and extraction workers. Elevated exposures to various cancer-causing substances in the workplace are more likely to occur in these types of occupations, although the particular exposures would differ for different occupations and possibly even workplaces. People in blue-collar occupations are also more likely to smoke or use tobacco[1]. The greater proportion employed in occupations with possible occupational exposures might account for a portion of the excess in cases compared with the New York State standard, but not when comparing the study area with New York State excluding New York City. There were insufficient data available to evaluate the possible contributions of specific occupations that are known to have a higher risk of bladder cancer, such as dye or rubber workers.

Bladder cancer has been associated with exposures to high levels of arsenic in the drinking water, and there is some evidence that it may be related to consumption of water disinfection byproducts (trihalomethanes). As discussed above, the quality of both municipal water and well water in the CFS study area is generally high. Testing has not shown arsenic in the drinking water. Disinfection byproducts occur when organic matter in the source water combines with chemicals used for disinfection. Levels of organic matter in water obtained from groundwater sources such as wells are generally much lower than in water obtained from surface water sources such as lakes, rivers and streams. Since drinking water in the study area is obtained from groundwater, levels of trihalomethanes would not be expected to be high. This is confirmed by the data for trihalomethanes in drinking water in the CFS area, which were not detected at levels above maximum contaminant levels. This review therefore provides no evidence that exposures to contaminants in drinking water in the CFS area contributed to the elevated incidence of bladder cancer.

Thyroid Cancer

The elevations in papillary tumors and tumors less than 2 cm are consistent with national trends. Researchers have attributed most of the recent increase in thyroid cancer to the greater detection of existing tumors rather than the greater occurrence of new tumors. While larger tumors might be found as a noticeable lump that would cause a patient to seek medical care, smaller tumors may not produce any symptoms and only be detectable by medical techniques. People with health care coverage and people with more contact with the medical care system would have greater opportunity to have medical imagery and other examinations performed. There may also be differences in local practices of medical imaging, use of sensitive diagnostic techniques, and clinical examination.

Most likely due to the greater medical surveillance received by this group, an elevated incidence of thyroid cancer has been observed in persons exposed to conditions at the World Trade Center site. Many of these people likely live in the CFS area. Most of the World Trade Center responders were males, and there was a greater percentage excess in males in the study area than in females. The median age of the rescue and recovery workers was in the late 30s to early 40s at the time of the attacks, or the late 40s to 50s between 2011 and 2015, while the people in the study area who were most affected by thyroid cancer were older and younger than that. In line with the typical occurrence of cancer among older people, however, older World Trade Center responders were more likely to develop cancer than younger responders (Li 2012). Quantitatively, even though cohort members may have been at 2-3 times greater risk of developing thyroid cancer compared to the general population, incidence in the general population was only about 16 cases/100,000 per year, so even if the incidence of thyroid cancer were tripled, very few of the cohort members living in the area would have been affected.

Obesity has also been associated with a greater risk of thyroid cancer, although the degree to which risk is increased in people who are obese is relatively small. Data from the BRFSS and SPARCS indicate that a greater proportion of people in the CFS study area are obese compared to Suffolk County as a whole and New York State excluding New York City. This difference may be especially pronounced among people in the oldest age groups, who have shown a particularly increased incidence of thyroid cancer.

Leukemia

Most of the children with leukemia lived in the Middle Country School District. There was no information available on whether any of the children with leukemia who lived in this school district actually attended public schools. About half of the children with leukemia were diagnosed in 2015. Many clusters of childhood leukemia have been reported in the scientific literature and encountered over the years in New York. Despite close investigation of potential personal and environmental risk factors, the majority of these are unexplained. It has been observed, however, that they are often time-limited and do not persist.

For the chronic leukemias, differences between the study area and Suffolk County on the one hand and New York State excluding New York City, on the other in the percentages of cases reported by laboratories only may simply indicate a different mix of reporting sources. However, if independent laboratories serving the study area and Suffolk County are reporting cancer cases more completely compared to elsewhere in the state and reporting by other non-hospital sources is equally complete, this may cause an apparent elevation in incidence in the study area and Suffolk County. Increased reporting of chronic leukemias by independent laboratories would be consistent with the time trend in case diagnoses, as there was a steady increase in cases of chronic leukemias during the time when reporting from independent laboratories was increasing.

Survey data suggest that a greater proportion of study area residents under age 65 had health care coverage, which would improve access to medical care. However, the greatest excesses in chronic leukemias were among older adults, ages 65 and over, the vast majority of whom have Medicare. Access to medical care is probably not as great an issue for childhood leukemias, since the acute leukemias typically seen in children have symptoms that would bring them to medical attention. Still, even for people with health care coverage, including Medicare, if people in Suffolk County had greater contact with the medical care system, this could increase the likelihood that more cases of chronic leukemias are detected incidentally on routine blood testing.

Both survey data and hospital discharge data suggest that people living in the CFS study area may be more likely to use tobacco than the average for the comparison populations. Smoking has been associated most closely with the AML type of leukemia and to some extent with CML, however those types were not significantly higher in the study area than in the comparison area. Taken by themselves, these types are relatively rare and an increased risk may not be detectable statistically.

Like New York State excluding New York City and Suffolk County, the study area has a greater proportion compared to New York State of people working in largely blue-collar occupations considered together, and of many blue-collar occupational groups, such as construction and extraction workers. Elevated exposures to various cancer-causing substances in the workplace are more likely to occur in these types of occupations, although the particular exposures would differ for different occupations and possibly even workplaces. People in blue-collar occupations are more likely to smoke or use tobacco[1]. The greater proportion employed in occupations with possible occupational exposures might account for a portion of the excess in cases compared with the New York State standard, but not when comparing the study area with New York State excluding New York City. There were insufficient data available to evaluate the possible contributions of specific occupations that may have a higher risk of leukemia, such as chemical workers.

The major types of leukemia, with the possible exception of CLL, have been associated with exposures to ionizing radiation. Exposure to the radioactive gas radon has not been associated with elevated risk of leukemia, and data from home testing for radon indicate that radon levels in the study area were generally lower than in the comparison areas. Some contaminated sites in New York contain radioactive materials, however there were no contaminated sites identified in the study area. There were no detections of radium or gross alpha or beta radiation from any source above allowable limits for either public water supplies or private wells.

Occupational exposure to the chemical benzene is an established risk factor for AML and may also be associated with CML and CLL. Occupational exposures to 1,3-butadiene have been associated with blood cancers such as leukemia. The levels of these substances encountered in workplaces are much higher than those found in the ambient environment. Measured concentrations of these substances at an air monitor close to the study area were generally above the DEC health-based AGC, and modeled concentrations in the study area translated to cancer risks above 1 in 1 million, but the concentrations did not stand out when compared to Suffolk County, New York State excluding New York City, or the entire state. It is not likely that air contaminants contributed to the elevated incidence of leukemia compared to New York State or New York State excluding New York City.

Childhood ALL has been associated with childhood and parental insecticide exposures, and childhood AML has been associated with maternal but not paternal occupational exposure to pesticides. There is also some evidence that CML and CLL may be associated with pesticide exposures, but this evidence is not as strong. The pesticide application database shows a lower level of pesticide applications by commercial operators in the study area compared to western Suffolk County. These pesticides were nearly all in products marketed for lawn care and not, for example, for agricultural use. Data from the pesticide database apply to commercial applicators only, however, and do not reflect applications by property owners. No information was available to assess non-commercial pesticide applications. The data available do not show higher exposures to pesticides in the study area.

Conclusions

An increased prevalence of smoking and tobacco use in the Centereach/Farmingville/Selden study area likely contributed to the elevated incidence of lung and bladder cancers, as well as several other types of cancer. Exposures to hazardous substances in the workplace can be important for lung and bladder cancers and some types of leukemia, however the information available did not indicate any particular occupation or workplace that may have played a role.

Some other factors may have accounted for elevations of specific cancers. Increased screening for lung cancer might have had a small effect on lung cancer incidence in this area, although any effect would not be distinguishable from the effects of chance. Most of the increased incidence of thyroid cancer in the study area is likely due to increased detection of small papillary tumors by medical imagery and other sophisticated diagnostic techniques. Increased surveillance would account for elevated diagnoses of thyroid cancers among people (mainly men) who had spent time in rescue and recovery efforts at the World Trade Center site, although the contribution of these people would likely be small. An increased prevalence of obesity in the area could have contributed to the increased incidence of thyroid cancer, but this contribution again would have been minor. The elevated number of cases of chronic leukemias, especially among elderly persons, could be the effect of more compliance with reporting by independent laboratories in the area, or may be related to medical care factors such as greater contact with the health care system.

This investigation uncovered no factors that might account for the elevated number of childhood leukemias. Given the large number of statistical comparisons made, it is possible that this finding occurred by chance. Even after intensive investigation, the causes of many reported clusters of childhood cancers remain unknown. These occurrences are often limited in time. Since about half of the cases occurred in the last year of the time period studied, the DOH will continue to monitor the incidence of childhood leukemia in the CFS area.

Levels of radon in indoor air, environmental contaminants in outdoor air, and contaminants in drinking water do not stand out from those in other parts of the state. There were no industrial or inactive hazardous waste disposal sites identified within the boundaries of the CFS study area, and evaluations of other sources of public concern have concluded that there was no apparent health hazard. Commercial pesticide applications in the ZIP Code area approximating the study area were less than in the comparison area for the years examined, although levels of use by homeowners and by commercial applicators in the past were not known.

Recommendations

The recommendations below are divided into two main sections: 1) recommended actions to address the specific cancers that were elevated in the Centereach/Farmingville/Selden study area, and 2) recommended actions to address all cancer types throughout New York State. Actions to address the specific cancers that were elevated in the CFS study area are organized around three categories: health promotion and cancer prevention; cancer screening and early detection; and healthy and safe environment. 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 also described at the end.

Recommended Actions Based on Specific Cancers Elevated in the Centereach/Farmingville/Selden Study Area

Health Promotion and Cancer Prevention

Tobacco Prevention: More work is needed to build on the progress NYS achieved as a result of tobacco- and smoke-free environments, high cigarette excise taxes, and health communication campaigns. While NYS lung cancer incidence and smoking rates are at record lows, further declines will only be achieved with a continued focus on eliminating tobacco as a major cancer risk factor.

Recommendation: Prevent initiation of tobacco use, including combustible tobacco and electronic vaping products, by youth and young adults.

Recommendation: Promote tobacco use cessation, especially among populations disproportionately affected by tobacco use including: low socioeconomic status; frequent mental distress/substance use disorder; lesbian, gay, bisexual and transgender; and disability.

Recommendation: Eliminate exposure to secondhand smoke and exposure to secondhand aerosol/emissions from electronic vapor products.

Healthy Nutrition and Physical Activity: It is estimated that up to one-third of all cancers may be attributed to excess weight, physical inactivity, and unhealthy diet. Adopting an active lifestyle, eating a healthy diet and maintaining a healthy weight can help lower the risk of cancer and improve cancer mortality rates.

Recommendation: Promote healthy eating and food security by:

- Increasing access to healthy and affordable foods and beverages,
- Increasing skills and knowledge to support healthy food and beverage choices,
- Increasing food security, and

- Increasing awareness of DOH sportfish advisories to promote healthier fish consumption choices while reducing chemical exposures (https://www.health.ny.gov/environmental/outdoors/fish/health_advisories/).

Recommendation: Increase physical activity by:

- Improving community environments that support active transportation and recreational physical activity for people of all ages and abilities,
- Promoting school, child care, and worksite environments that support physical activity for people of all ages and abilities, and
- Increasing access, for people of all ages and abilities, to safe indoor and/or outdoor places for physical activity.

Cancer Screening and Early Detection

The Centers for Disease Control and Prevention (CDC) and DOH support the screening recommendations of the U.S. Preventive Services Taskforce (USPSTF). The USPSTF is an independent panel of national experts that makes recommendations about the effectiveness of cancer screening and other preventive care services for patients without signs or symptoms. The panel examines the benefits and harms of the screening or service and does not consider costs as part of the assessment. The USPSTF recommends routine screening for breast, cervical, colorectal, and lung cancers.

Lung Cancer Screening: Since 2013, the U.S. Preventive Services Task Force has recommended lung cancer screening by low-dose CT scan for high-risk individuals between ages 55 and 80 years who have a history of heavy smoking and either currently smoke or have quit within the past 15 years. However, studies have shown very few heavy smokers who meet these criteria receive lung cancer screening.

Recommendation: Educate men and women who meet the criteria for lung cancer screening about the benefits and risks of screening to help them make informed decisions.

Recommendation: Healthcare providers need tools and support to engage with patients who may benefit from screening, and facilities adopting lung cancer screening programs should be following national guidelines for a quality program.

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. (Note: This recommendation does not apply to people who have a family history of medullary thyroid cancer; these individuals may need genetic testing, blood testing and/or thyroid ultrasounds.)

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

Childhood Leukemia Incidence: This investigation found a significant excess in numbers of cases of leukemia in children in the Centereach/Farmingville/Selden study area. Even after intensive investigation, the causes of many reported clusters of childhood cancers remain unknown, although these occurrences are often limited in time. Closer examination of available data could not account for the findings of the present investigation but showed that about half the cases were diagnosed in the last year of the five-year period studied.

Recommendation: DOH will continue to monitor the incidence of childhood leukemia in the Centereach/Farmingville/Selden study area.

Healthy and Safe Environment

Radon Testing and Mitigation: Radon is a naturally occurring, radioactive gas found in soil and rock. It seeps into homes through cracks in the foundation, walls, and joints. Radon comes from the breakdown of uranium in soil, rock and water and gets into the air people breathe. Radon is the second leading cause of lung cancer. Many individuals may not be aware that radon is the second leading cause of lung cancer.

Recommendation: Improve the public's awareness about the relationship between indoor radon exposure and lung cancer by conducting outreach and education about building testing and remediation. Promote the DOH's free and low-cost radon test kit programs, provision of test kits at half price to schools and daycares, and free test kits as part of the DOH's Healthy Neighborhoods Program and other grant-funded programs.

Recommendation: Explore local level policy and/or code adoption to require radon resistant construction in high radon areas.

Recommendation: Promote healthcare provider screening for radon testing particularly in high-risk radon areas. Increase the number of physicians that ask their patients if they have had their homes tested for radon and refer them to the DOH, as needed. Add radon testing questions to routine electronic medical questionnaires.

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.

Safety in the Workplace: Exposure to substances in the workplace may increase cancer risk. This includes prolonged or intense exposure (in higher concentrations than typically found outside the workplace) to UV radiation, toxic wastes, agricultural pesticides, some industrial and manufacturing products, some outdoor landscaping materials, and hazardous substances such as asbestos, arsenic, benzene, chromium, vinyl chloride, and silica.

Recommendation: Develop targeted occupational safety and health training programs for employers and workers in high-risk jobs.

Recommendation: Incorporate industry and occupation into electronic health records and other patient-oriented databases.

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 partners 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.

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) works 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/
- 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 organizations 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 six-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 Diseases; 2) Promote a Healthy and Safe Environment; 3) Promote Healthy Women, Infants and Children; 4) Promote Well-Being and Prevent Mental and Substance Use Disorders; and 5) Prevent Communicable Diseases. 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/.

References

Introduction

1. American Cancer Society. *Cancer Facts & Figures 2018*. Atlanta: American Cancer Society; 2018.

Lung Cancer

1. Cronin KA, Lake AJ, Scott S et al: Annual Report to the Nation on the Status of Cancer, Part I: National Cancer Statistics. *Cancer 124* (13): 2785-2800, 2018.
2. American Lung Association, *Trends in Lung Cancer: Morbidity and Mortality*. American Lung Association, Epidemiology and Statistics Unit, Research and Program Services Division, 2014.
3. Hackshaw AK, Law MR, Wald NJ: The accumulated evidence on lung cancer and environmental tobacco smoke. *BMJ 315* (7114): 980-8, 1997.
4. Lorigan P, Califano R, Faivre-Finn C, et al.: Lung cancer after treatment for breast cancer. *Lancet Oncol 11* (12): 1184-92, 2010.
5. Matakidou A, Eisen T, Houlston RS: Systematic review of the relationship between family history and lung cancer risk. *Br J Cancer 93* (7): 825-33, 2005.
6. Gallicchio L, Boyd K, Matanoski G, et al.: Carotenoids and the risk of developing lung cancer: a systematic review. *Am J Clin Nutr* 88 (2): 372-83, 2008.
7. Krewski D, Lubin JH, Zielinski JM, et al.: Residential radon and risk of lung cancer: a combined analysis of 7 North American case-control studies. *Epidemiology 16* (2): 137-45, 2005.
8. Environmental Protection Agency, Exposure to Radon Causes Lung Cancer in Non-smokers and Smokers Alike. Washington, DC: Environmental Protection Agency, 2011. Available online. Last accessed September 6, 2018.
9. Vineis P, Forastiere F, Hoek G, et al.: Outdoor air pollution and lung cancer: recent epidemiologic evidence. *Int J Cancer 111* (5): 647-52, 2004.
10. Field, RW, Withers BL: Occupational and Environmental Causes of Lung Cancer. *Clin Chest Med 33* (4): 681–703, 2012.
11. Pesch B, Kendzia B, Gustavsson P, Jockel K-H, Johnen G, Pohlabeln H, et al. Cigarette smoking and lung cancer--relative risk estimates for the major histological types from a pooled analysis of case-control studies. *International Journal of Cancer*, 2012; *131* (5): p.1210–1219.
12. Khuder SA. Effect of cigarette smoking on major histological types of lung cancer: a meta-analysis. *Lung Cancer*, 2001; *31* (2–3): p.139–148.
13. Lee PN, Forey BA, Coombs KJ. Systematic review with meta-analysis of the epidemiological evidence in the 1900s relating smoking to lung cancer. *BMC Cancer*, 2012; *12*: p.385.
14. U.S. Preventive Services Task Force, Final Update Summary: Lung Cancer: Screening. U.S. Preventive Services Task Force. July 2015. https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/lung-cancer-screening. Accessed October 31, 2018.

Bladder Cancer

1. Islami F, Sauer, AD, Miller, KD et al.: Proportion and Number of Cancer Cases and Deaths Attributable to Potentially Modifiable Risk Factors in the United States. *Ca Cancer J Clin 68* (1): 31–54, 2018.
2. Vineis P, Simonato L: Proportion of lung and bladder cancers in males resulting from occupation: a systematic approach. *Arch Environ Health 46*: 6–15, 1991.
3. Cumberbatch MGK, Cox A, Teare, D et al.: Contemporary occupational carcinogen exposure and bladder cancer: A systematic review and meta-analysis. *JAMA Oncol 1* (9): 1282-1290, 2015.
4. Olfert, SM, Felknor SA, Delclos G: An updated review of the literature: Risk factors for bladder cancer with focus on occupational exposures. *Southern Medical Journal 99* (11): 1256-1263, 2006.
5. Anawar HM, Akai J, Mostofa KM, et al: Arsenic poisoning in groundwater: Health risk and geochemical sources in Bangladesh. *Environ Int 27*: 597–604, 2002.
6. Villanueva CM, Cantor KP, Grimalt JO et al.: Bladder cancer and exposure to water disinfection by-products through ingestion, bathing, showering, and swimming in pools. *Am J Epidemiol 165*:148–156, 2007.
7. Negri E, La Vecchia C: Epidemiology and prevention of bladder cancer. *Eur J Cancer Prev 10*: 7-14, 2001.
8. Kaldor JM, Day NE, Kittelmann B et al.: Bladder tumours following chemotherapy and radiotherapy for ovarian cancer: a case-control study. *Int J Cancer 63*: 1–6, 1995.
9. Steinmaus CM, Nunez S, Smith AH: Diet and bladder cancer: a meta-analysis of six dietary variables. *Am J Epidemiol 151*: 693–702, 2000.
10. Travis LB, Curtis RE, Glimelius B et al.: Bladder and kidney cancer following cyclophosphamide therapy for non-Hodgkin's lymphoma. *J Natl Cancer Inst 87*: 524–30, 1995.
11. Tang H, Shi W, Fu S et al.: Pioglitazone and bladder cancer risk: A systematic review and meta-analysis. *Cancer Medicine 7* (4): 1070–1080, 2018.
12. Michaud DS, Spiegelman D, Clinton SK, et al.: Fluid intake and the risk of bladder cancer in men. *New Engl J Med 340*: 1390-1397, 1999.

Thyroid Cancer

1. Vaccarella S, Franceschi S, Bray F, Wild CP, Plummer M, Dal Maso L. Worldwide Thyroid-Cancer Epidemic? The Increasing Impact of Overdiagnosis. *New Engl J Med 375*: 614-617, 2016.
2. Sanabria A, Kowalksi LP, Shah JP, Nixon IJ, Angelos P, Williams MD, Rinaldo A, Ferlito A. Growing incidence of thyroid carcinoma in recent years: factors underlying diagnosis. *Head and Neck 40*: 855-866, 2018.
3. LaVecchia C, Negri E. The thyroid cancer epidemic – overdiagnosis or a real increase? *Nature Reviews Endocrinology 13*: 318-319, 2017.
4. Ron E, Lubin JH, Shore RE, Mabuchi K, Modan B, Pottern LM, Schneider AB, Tucker MA, Boice Jr. JD. Thyroid cancer after exposure to external radiation: a pooled analysis of seven studies. *Radiation Research 141*:259-277, 1995.

5. DeGonzález AB, Bouville A, Rajaraman P, Schubauer-Berigan M. Ionizing radiation. In *Schottenfeld and Fraumeni Cancer Epidemiology and Prevention, 4th ed.* Thun M, Linet MS, Cerhan JR, Haiman CA, Schottenfeld D, eds. Oxford: Oxford University Press, 2018. pp. 227-248.
6. Bosch de Basea M, Morina D, Figuerola J, Barber I, Muchart J, Lee C, Cardis E. Subtle excess in lifetime cancer risk related to CT scanning in Spanish young people. *Environment International 120*:1-10, 2018.
7. Zablotska LB, Nadyrov EA, Polyanskaya ON, McConnell RJ, O'Kane P, Lubin J, Hatch M, Little MP, Brenner AV, Veyalkin IV, Yauseyenka VV, Bouville A, Drozdovitch VV, Minenko VF, Demidchik YE, Mabuchi K, Rozhko AV. Risk of thyroid follicular adenoma among children and adolescents in Belarus exposed to iodine-131 after the Chornobyl accident. *Am J Epidemiology 182*:781-790, 2015.
8. Yamashita S, Saenko V. Mechanisms of disease: molecular genetics of childhood thyroid cancers. *Nature Clinical Practice Endocrinology and Metabolism 3*:422-429 2007.
9. Chang LA, Miller DL, Lee C, Melo DR, Villoing D, Drozdovitch V, Thierry-Chef I, Winters SJ, Labrake M, Myers CF, Lim H, Kitahara CM, Linet MS, Simon SL. Thyroid radiation dose to patients from diagnostic radiology procedures over eight decades: 1930-2010. *Health Physics 113*:458-473, 2017.
10. Han MA, Kim JH. Diagnostic x-ray exposure and thyroid cancer risk: systematic review and meta-analysis. *Thyroid 28*: 220-228, 2018.
11. Goldfarb M, Freyer DR. Comparison of secondary and primary thyroid cancer in adolescents and young adults. *Cancer 120*:1155-1161, 2014.
12. Cardis E, Howe G, Ron E, Bebeshko V, Bogdanova T, Bouville A, Carr Z, Chumak V, Davis S, Demidchik Y, Drozdovitch V, Gentner N, Gudzenko N, Hatch M, Ivanov V, Jacob P, Kapitonova E, Kenigsberg Y, Kesminiene A, Kopecky KJ, Kryuchkov V, Loos A, Pinchera A, Reiners C, Repacholi M, Shibata Y, Shore RE, Thomas G, Tirmarche M, Yamashita S, Zvonova I. Cancer consequences of the Chernobyl accident: 20 years on. *Journal of Radiological Protection 26*: 127-140, 2006.
13. Wakeford R. The cancer epidemiology of radiation. *Oncogene 23*: 6404-6428, 2004.
14. Zimmerman MB, Galetti V. Iodine intake as a risk factor for thyroid cancer: a comprehensive review of animal and human studies. *Thyroid Research 8*:8, 2015.
15. Lauby-Secretan BA, Scoccianti C, Loomis D*, et al.*, Body fatness and cancer - viewpoint of the IARC Working Group*, New Engl J Med*, *375* (8):794-798, 2016.
16. Pearson-Stuttard J, Zhou B, Kontis V*,* et al., Worldwide burden of cancer attributable to diabetes and high body-mass index: a comparative risk assessment*. The Lancet Diabetes & Endocrinology, 6* (6): e6-e15, 2018.
17. Drilon A, Hu ZI, Lai GGY, Tan DSW. Targeting RET-driven cancers: lessons from evolving preclinical and clinical landscapes. *Nature Reviews Clinical Oncology 15*:151-167, 2018.
18. Romei C, Ciampi R, Elisei R. A comprehensive overview of the role of the RET proto-oncogene in thyroid carcinoma. *Nature Reviews Endocrinology* 12: 192-202, 2016.
19. Guilmette J, Nosé V. Hereditary and familial thyroid tumors. *Histopathology* 72:70-81, 2018.
20. Yang SP, Ngeow J. Familial non-medullary thyroid cancer: unravelling the genetic maze. *Endocrine-Related Cancer* R577-R595, 2016.
21. Mester J, Eng C. Cowden Syndrome: recognizing and managing a not-so-rare hereditary cancer syndrome. *Journal of Surgical Oncology 111*: 125-130, 2015.

22. Wang X, Cheng W, Li J, Su A, Wei T, Liu F, Zhu J. Familial nonmedullary thyroid carcinoma is a more aggressive disease: a systematic review and meta-analysis. *European Journal of Endocrinology* 172: R253-R262, 2015.
23. Nixon IJ, Suárez C, Simo R, Sanabria A, Angelos P, Rinaldo A, Rodrigo JP, Kowalski LP, Hartl DM, Hinni ML, Shah JP, Ferlito A. The impact of family history on non-medullary thyroid cancer. *European Journal of Surgical Oncology 42*: 1455-1463, 2016.
24. Bresner L, Banach R, Rodin G, Thabane L, Ezzat S, Sawka AM. Cancer-related worry in Canadian thyroid cancer survivors. *Journal of Clinical Endocrinology and Metabolism 100*: 977-985, 2015.
25. Davies L and Welch HG, Increasing incidence of thyroid cancer in the United States, 1973-2002. *JAMA 295*(18): 2164-2167, 2006.

Leukemias

1. American Cancer Society, *Cancer facts and figures*. 2018, Atlanta, GA.
2. Mezei G, Sudan M, Izraeli S, et al., Epidemiology of childhood leukemia in the presence and absence of Down syndrome, *Cancer Epidemiology 38*(5):479-489, 2014.
3. Doll R and Wakeford R, Risk of childhood cancer from fetal irradiation. *British Journal of Radiology 70*(830):130-139, 1997.
4. Wertheimer N and Leeper ED, Electrical wiring configurations and childhood cancer, *American Journal of Epidemiology 109*(3):273-284, 1979.
5. Teepen JC and van Dijck JAAM, Impact of high electromagnetic field levels on childhood leukemia incidence *International Journal of Cancer*, *131*(4):769-778, 2012.
6. Tower RL and Spector LG, The epidemiology of childhood leukemia with a focus on birth weight and diet, *Critical Reviews in Clinical Laboratory Sciences 44*(3):203-242, 2007.
7. Linabery AM, Jurek AM, Duval S, et al., The association between atopy and childhood/adolescent leukemia: a meta-analysis, *American Journal of Epidemiology 171* (7): 749-764, 2010.
8. McNally RJQ and Parker L, Environmental factors and childhood acute leukemias and lymphomas, *Leukemia & Lymphoma 47*(4):583-598, 2006.
9. Buffler PA, Kwan ML, Reynolds P, *et al.*, Environmental and genetic risk factors for childhood leukemia: appraising the evidence, *Cancer Investigation 23*(1):60-75, 2005.
10. Van Steensel-Moll HA, Valkenburg HA and Van Zanen GE, Childhood leukemia and parental occupation: a register-based case-control study, *American Journal of Epidemiology 121*(2): 216-224, 1985.
11. Shu XO, Gao YT, Tu JT, et al., A population-based case-control study of childhood leukemia in Shanghai, *Cancer 62*(3):635-644, 1988.
12. Buckley JD, Buckley CM, Ruccione K, et al., Epidemiological characteristics of childhood acute lymphocytic leukemia. Analysis by immunophenotype. The Childrens Cancer Group. *Leukemia 8*(5):856-864, 1994.
13. Spycher BD, Feller M, Röösli M, et al., Childhood cancer and residential exposure to highways: a nationwide cohort study. *European Journal of Epidemiology 30*(12):1263-1275, 2015.

14. Von Behren J, Reynolds P, Gunier RB, et al., Residential traffic density and childhood leukemia risk. *Cancer Epidemiology and Prevention Biomarkers 17*(9):2298-2301, 2008.
15. Terry PD, Shore DL, Rauscher GH, *et al.*, Occupation, hobbies, and acute leukemia in adults, *Leukemia Research 29*(10):1117-1130, 2005.
16. Towle KM, Grespin ME and Monnot AD, Personal use of hair dyes and risk of leukemia: a systematic literature review and meta-analysis, *Cancer Medicine 6*(10):2471-2486, 2017.
17. Iwanaga M, Watanabe T and Yamaguchi K, Adult T-cell leukemia: a review of epidemiological evidence, *Frontiers in Microbiology 3*:322, 2012.
18. Xavier AC, Ge Y and Taub JW, Down syndrome and malignancies: a unique clinical relationship: a paper from the 2008 William Beaumont Hospital Symposium on Molecular Pathology. *The Journal of Molecular Diagnostics 11*(5):371-380, 2009.
19. Johnson KJ, Carozza SE, Chow EJ, *et al.*, Parental age and risk of childhood cancer: a pooled analysis. *Epidemiology 20*(4):475-483, 2009.
20. Dockerty JD, Draper G, Vincent T, *et al.*, Case-control study of parental age, parity and socioeconomic level in relation to childhood cancers. *International Journal of Epidemiology 30*(6):1428-1437, 2001.
21. Ross JA. Potter JD, Shu X-O., *et al.*, Evaluating the relationships among maternal reproductive history, birth characteristics, and infant leukemia: a report from the Children's Cancer Group, *Annals of Epidemiology 7*(3):172-179, 1997.
22. Ma X, Metayer C, Does MB, *et al.*, Maternal pregnancy loss, birth characteristics, and childhood leukemia (United States). *Cancer Causes & Control 16*(9):1075-1083, 2005.
23. Latino-Martel P, Chan DSM, Druesne-Pecollo N, *et al.*, Maternal alcohol consumption during pregnancy and risk of childhood leukemia: systematic review and meta-analysis. *Cancer Epidemiology and Prevention Biomarkers 19*(5):1238-1260, 2010.
24. Klimentopoulou A, Antonopoulos CN, Papadopoulou C, *et al.*, Maternal smoking during pregnancy and risk for childhood leukemia: A nationwide case-control study in Greece and meta-analysis, *Pediatric Blood & Cancer 58* (3):344-351, 2012.
25. Wigle DT, Turner MC and Krewski D, A systematic review and meta-analysis of childhood leukemia and parental occupational pesticide exposure, *Environmental Health Perspectives, 117*(10):1505-1513, 2009.
26. Kwan ML, Buffler PA, Abrams B, *et al.*, Breastfeeding and the risk of childhood leukemia: a meta-analysis. *Public Health Reports 119*(6):521-535, 2004.
27. Kossman SE and Weiss MA, Acute myelogenous leukemia after exposure to strontium-89 for the treatment of adenocarcinoma of the prostate. *Cancer 88*(3):620-624, 2000.
28. Rosner F, Cancer and secondary leukemia, *Bulletin du Cancer 70*(1):55-60, 1983.
29. Savitz DA and Andrews KW, Review of epidemiologic evidence on benzene and lymphatic and hematopoietic cancers, *American Journal of Industrial Medicine 31*(3):287-295, 1997.
30. Deschler B and Lübbert M, Acute myeloid leukemia: epidemiology and etiology. *Cancer 107*(9):2099-2107, 2006.
31. Islami F, Goding Sauer A, Miller KD, *et al.*, Proportion and number of cancer cases and deaths attributable to potentially modifiable risk factors in the United States, *CA: a Cancer Journal for Clinicians 68* (1):31-54 2018.
32. Poynter JN, Richardson M, Blair CK, *et al.*, Obesity over the life course and risk of acute myeloid leukemia and myelodysplastic syndromes, *Cancer Epidemiology 40*:134-140, 2016.

33. Goldin LR, Pfeiffer RM, Li X, *et al.*, Familial risk of lymphoproliferative tumors in families of patients with chronic lymphocytic leukemia: results from the Swedish Family-Cancer Database, *Blood 104*(6):1850-1854, 2004.
34. Linet MS, Schubauer-Berigan MK, Weisenburger DD, *et al.*, Chronic lymphocytic leukaemia: an overview of aetiology in light of recent developments in classification and pathogenesis. *British Journal of Haematology 139*(5)672-686, 2007.
35. Milham Jr S, Mortality from leukemia in workers exposed to electrical and magnetic fields, *New Engl J of Med 307*(4):249, 1982.
36. Wang H, Murat Y, Nomura S, *et al.*, A meta-analysis of epidemiological studies on the relationship between occupational electromagnetic field exposure and the risk of adult leukemia. *Environmental Health and Preventive Medicine 5*(1):43-46, 2000.
37. Charbotel B, Fervers B and Droz JP, Occupational exposures in rare cancers: A critical review of the literature. *Critical Reviews in Oncology/Hematology 90*(2):99-134, 2014.
38. Landgren O, Engels EA, Caporaso NE, *et al.*, Patterns of autoimmunity and subsequent chronic lymphocytic leukemia in Nordic countries, *Blood 108*(1):292-296, 2006.
39. Landgren O, Rapkin JS, Caporaso NE, *et al.*, Respiratory tract infections and subsequent risk of chronic lymphocytic leukemia. *Blood 109*(5):2198-2201, 2007.
40. Morton LM, Hartg, P, Holford TR, *et al.*, Cigarette smoking and risk of non-Hodgkin lymphoma: a pooled analysis from the International Lymphoma Epidemiology Consortium (interlymph), *Cancer Epidemiology and Prevention Biomarkers 14*(4):925-933, 2005.
41. Tsa, H-T, Cross AJ, Graubard BI, *et al.*, Dietary factors and risk of chronic lymphocytic leukemia and small lymphocytic lymphoma: a pooled analysis of two prospective studies. *Cancer Epidemiology and Prevention Biomarkers 19*(10):2680-2684, 2010.
42. Nazha A, Prebet T, Gore S, *et al.*, Chronic myelomoncytic leukemia: Are we finally solving the identity crisis? *Blood Reviews 30*(5):381-388, 2016.
43. Heyssel R, Brill AB, Woodbury LA, *et al.*, Leukemia in Hiroshima atomic bomb survivors. *Blood 15*(3):313-331, 1960.
44. Höglund M, Sandin F and Simonsson B, Epidemiology of chronic myeloid leukaemia: an update. *Annals of Hematology 94* (S2):241-247, 2015.
45. Qin L, Deng H-Y, Chen S-J, *et al.*, Relationship between cigarette smoking and risk of chronic myeloid leukaemia: a meta-analysis of epidemiological studies. *Hematology 22*(4):193-200, 2017.
46. Björkholm M, Kristinsson SY, Landgren O, *et al.*, No familial aggregation in chronic myeloid leukemia, *Blood 122*(3):460-461, 2013.
47. Rota M, Porta L, Pelucchi C, *et al.*, Alcohol drinking and risk of leukemia - a systematic review and meta-analysis of the dose-risk relation, *Cancer Epidemiology 38*(4):339-345, 2014.
48. Takahashi K, Pemmaraju N, Strati P, *et al.*, Clinical characteristics and outcomes of therapy-related chronic myelomonocytic leukemia. *Blood 122*(16):2807-2811, 2013.
49. Polychronakis I, Dounias G, Makropoulos V, *et al.*, Work-related leukemia: a systematic review, *Journal of Occupational Medicine and Toxicology 8*(1):14, 2013.
50. Van Maele-Fabry GV, Duhayon S and Lison D, A systematic review of myeloid leukemias and occupational pesticide exposure. *Cancer Causes & Control 18*(5):457-478, 2007.

World Trade Center

1. Boffetta P, Zeig-Owens R, Wallenstein S, et al.: Cancer in World Trade Center responders: finding from multiple cohorts and options for future study. *Am J Indust Med 59*:96-105, 2016.
2. Li J, Brackbill RM, Liao T, et al.: Ten-year cancer incidence in rescue/recovery workers and civilians exposed to the September 11, 2001 terrorist attacks on the World Trade Center. *Am J Indust Med 59*:709-721, 2016.

Study limitations

1. Copeland G, Green D, Firth R, Wohler B, Wu XC, Schymura M, De P, Hofferkamp J, Sherman R, Kohler B (eds). *Cancer in North America: 2011-2015. Appendix D – Data Quality Indicators by Year and Registry.* Springfield, IL: North American Association of Central Cancer Registries, Inc. June 2018.

Interpretation

1. Ham DC, Przybeck T, Strickland JR, Luke DA, Bierut LJ, Evanoff BA. Occupation and Workplace Policies Predict Smoking Behaviors: Analysis of National Data from the Current Population Survey, *Journal of Occupational and Environmental Medicine 53*(11):1337-45, 2011.

Appendix 1: Sources of Data

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 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 (eBRFSS), is a county-level survey that augments the CDC Behavioral Risk Factor Surveillance System (BRFSS)[1]. The eBRFSS 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 eBRFSS 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 eBRFSS 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. The sampling plan resulted in a sufficient sample size to enable calculation of health indicators for several cities in Upstate New York (n=31,690). In 2016, the eBRFSS was sampled to produce valid estimates for all 62 counties (n =34,058). Weights were developed for both the 2013-14 and 2016 eBRFSS to enable the calculation of estimated population rates using a two-stage method developed by CDC[2]. 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 eBRFSS, weighting was completed by Clearwater Research[3]. For the 2016 eBRFSS, CDC calculated the weights. To support the calculation of sub-county units, data collected in the 2013-14 and 2016 eBRFSS were combined. A common weight was developed to enable the calculation of population estimates from the sample of New York residents responding to the survey.

To support small area estimation for the study communities, eBRFSS data from residents in selected ZIP Codes were aggregated and weighted to generate population estimates for the ZIP Code area using direct estimation methods. The ability for eBRFSS data to calculate reliable small area estimates for sub-county units was established during a pilot funded by the Robert Wood Johnson Foundation County Health Rankings and Roadmaps Program[4].

References

1. New York State Expanded Behavioral Risk Factor Surveillance System https://www.health.ny.gov/statistics/brfss/expanded/.
2. Pierannunzi C, Town M, Garvin W, Shaw FE, Balluz L. Methodologic changes in the Behavioral Risk Factor Surveillance System in 2011 and potential effects on prevalence estimates. *MMWR Morb Mortal Wkly Rep 61*(22):410-3, 2012.
3. 2013-14 New York Expanded BRFSS Survey: Technical Report https://www.health.ny.gov/statistics/brfss/expanded/2013/docs/technical_report.pdf.
4. Sub-County Health Data Report For County Health Rankings- Related Measures 2016 http://www.nysachoinfo.org/Sub-County-Health-Data-Report/Albany.pdf.

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/)

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/)

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 (EPA) 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 EPA’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 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. The current list includes 187 HAPs. The Clean Air Act requires US EPA 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 US EPA's web site at https://www.epa.gov/haps.

DEC establishes both short-term and long-term air concentration guideline values for toxic air pollutants (including the subset known as known as EPA- HAPs) by adopting the most health-protective, scientifically valid, value developed by DEC, EPA, 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 *US EPA'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, lead, and total suspended particulates and particulate matter less than 2.5 and 10 microns (PM2.5 & PM10) in diameter. Even though toxicological data do not indicate that these pollutants are environmental risk factors for cancer, DOH researchers use 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 in Centereach/Farmingville/Selden (Suffolk County). Ozone was not evaluated because it is not directly released from sources but rather formed from volatile organic compounds (VOCs) in the presence of sunlight downwind of sources.

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 (VOCs) in a 1 in 6-day interval. This network has measured air pollutants that are known or likely 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.

More information on DEC's air monitoring program and data can be found at http://www.dec.ny.gov/chemical/8406.html.

Air Quality Modeled Concentrations

EPA 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 EPA-designated HAPs included in the model has varied from 32 for the 1996 NATA to 180 plus diesel particulate matter for the 2014 NATA. EPA 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. US EPA 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. EPA included emissions from mobile sources such as motor vehicles, trains, planes, airports, boats and ports, and emissions from farming and construction equipment in the modeling estimates. EPA 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 that are considered known or likely human carcinogens based on authoritative review from agencies such as the International Agency for Research on Cancer (IARC), EPA's Integrated Risk Information System (IRIS) and the US Department of Health and Human Services' National Toxicology Program (NTP) 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.

Air Quality Permit and Inventory Data

The DEC air permitting information and inventory data could 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 pollutants 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 reported on the individual state facility permit applications. Registrations are issued for small sources of air pollution and emission information collected on the registration forms is extremely limited. Prior to the 1990 Clean Air Act and the 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.

Radon Evaluation

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 EPA, 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 concentrations 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 way 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 is more tamper resistant than charcoal canisters. Radon concentrations 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 concentrations 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 EPA's action level of 4 picocuries per liter of air (4 pCi/l), the DOH recommends that the homeowner take appropriate corrective action.

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 concentrations 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 CFS study area and comparison areas including Suffolk County, 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 the CFS study area to display average radon concentrations by census block group. Researchers also compared study area radon test data with other geographic areas mentioned above.

Drinking Water Evaluation

Background

A public water system is an entity that 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. Although private wells are not regulated to the same extent as public and community water systems, DOH researchers obtained private well surveillance data from the Suffolk County Water Authority using the same approach as applied to the public water systems.

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 EPA. These national drinking water standards first went into effect in 1977.

Violations of these regulations occur when federally (EPA) 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. In this study, the same contaminant parameters were applied to the four study areas and all exceedances were reviewed, although the exceedance might not have led to a violation being issued. In cases where violations were issued, a *Violation* section has been added. In each case, affected water systems returned to compliance.

Data Sources

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 EPA to store information about public water systems and their violations of the EPA'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 EPA protect public health. States supervise the public water systems within their jurisdictions to ensure that each system meets state and EPA 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 EPA.

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 EPA have taken to ensure that a public water system returns to compliance if it is in violation of a drinking water regulation.

Suffolk County Department of Health Services, Office of Water Resources (1997-2018). Contamination data for the CFS study area were gathered from the Suffolk County Department of Health Services, Office of Water Resources and were not available in SDWIS to the extent required for this study. The Office of Water Resources is empowered by the federal Safe Drinking Water Act (SDWA), and the New York State and Suffolk County Sanitary Codes to enforce regulations controlling 39 Community Water Supplies (CWS) and 254 Non-Community Water Supplies (NCWS) in Suffolk County. Over 100,000 sampling records were available for points within the distribution system of the Suffolk County Water Authority that fell inside the CFS study area which were all analyzed as part of this study and comprised a separate dataset from SDWIS. This dataset also included private well data.

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.

Unregulated Contaminant Data. The third Unregulated Contaminant Monitoring Rule (UCMR 3) was published by the EPA on May 2, 2012. As required by the UCMR 3, EPA 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. The UCMR 3 (2013-2015) Occurrence Data show the number of people potentially being exposed and an estimate of 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)

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. DEC's online database of remedial sites in New York State may be accessed at https://www.dec.ny.gov/cfmx/extapps/derexternal/index.cfm?pageid=3.

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, DOH staff prepare public health assessments for federal superfund sites under an agreement with the federal Agency for Toxic Substances and Disease Registry. Staff also conduct exposure investigations as part of the state's Cancer Surveillance Improvement Initiative.

Pesticide Evaluation

DOH researchers used the available data on commercial pesticide use to assess whether any unusual patterns exist in the CFS study area. The New York State Pesticide Reporting Law, enacted in 1996, requires that commercial applicators maintain a record of each pesticide application made. The record includes the street address of the application, including the county and ZIP Code, the EPA Registration number for each product applied and the quantity, in pounds or gallons, of each product applied. The data are entered into a database and are made publicly available at the ZIP Code and county level on the Pesticide Sales and Use Reporting (PSUR) webpage maintained by the Cornell University Cooperative Extension. Commercial pesticide sales and application data are currently available for the years 1997 through 2016. It is important to note that applications of pesticides by property owners are not captured in this database and that these types of applications are likely be greater in number than commercial applications. The PSUR data is available on line at http://psur.cce.cornell.edu/.

For this evaluation, pesticide application data at the ZIP Code level were downloaded for the years 2000 through 2013. Data for the years 2014 through 2016 were not included because they are still under quality control review by the staff that manage the PSUR database. Data prior to the year 2000 were not included because a prior evaluation of the data conducted at CEH found the data for these years contain an unacceptably high number of reporting errors, most likely due to the applicators' unfamiliarity with the reporting process, which was new at that time.

Tables containing ZIP Code level pesticide applications data for the years 2000 through 2013 were downloaded from the PSUR website. The data for each year are contained in a separate table that contains the ZIP Codes where the applications occurred, the EPA Registration Number for each product applied and the total pounds or gallons of each product applied for the year within the corresponding ZIP Code. A column was added to each of the tables downloaded to include the application year. The tables were imported into a Microsoft Access database where they were then combined so all years could be queried simultaneously.

Tables from the US EPA's Pesticide Product Information System (PPIS) that contain information including product name, formulation (granular, Ready-to-Use Solution, etc.), as well as the name and percentage of active ingredients contained in each of the products, were also downloaded and imported into the Access database.

For both areas examined, the total pounds or gallons of each product applied over the fourteen-year period were determined. It was found that several hundred pesticide products, in both the liquid and solid phases, were applied in each of the areas. Next, the pesticide products accounting for 90 percent of the total pounds or gallons of products applied were determined. This reduced the number of products to be evaluated from several hundred to several dozen. These products were then matched to information from the PPIS tables to determine the names and the percentages of active ingredients contained in each. Using this information, the quantities of active ingredients applied for each product were calculated. The sum of each active ingredient applied over the fourteen-year period was then obtained for the areas to be compared. The data were normalized based on the total land area and the total number of households in each of the areas. Land area and total number of households were determined using ZIP Code and 2010 Census data and Geographic Information System software. In addition, the relative amounts of each of the active ingredients applied in each of the areas was determined.

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 2: Supplemental Tables

Study Setting and Initial Findings

Table 1a. Census tracts and block groups included in the Centereach/Farmingville/Selden study area

Census Tracts	Block Group(s)
1581.03	2
1581.04	1, 2, 3 (all)
1581.10	1, 2 (all)
1581.11	1, 2 (all)
1581.12	1, 2 (all)
1581.15	2, 3
1581.16	1, 2 (all)
1585.07	1, 2, 3 (all)
1585.08	2, 3, 4, 1+5* (all)
1585.09	1, 2, 3 (all)
1585.10	1, 2, 3, 4 (all)
1585.11	1, 2, 3 (all)
1586.05	2
1586.06	1, 2, 3 (all)
1587.04	1, 3, 5

*Block groups 1 and 5 were combined into small area 36103DOH112 in the Environmental Facilities and Cancer Mapping application.

Table 1b. Sociodemographics of the Centereach/Farmingville/Selden study area compared to New York State, New York State excluding New York City and Suffolk County

Characteristic	New York State		NYS excl. NYC		Suffolk County		CFS study area*	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Population								
Males								
00-14 years	1,793,401	18.80	1,025,127	18.55	141,212	19.10	7,774	19.75
15-24 years	1,383,961	14.50	828,436	14.99	104,948	14.20	5,824	14.80
25-34 years	1,391,208	14.58	675,451	12.22	86,792	11.74	4,966	12.62
35-44 years	1,239,681	12.99	669,441	12.11	95,962	12.98	5,706	14.50
45-54 years	1,369,873	14.36	836,219	15.13	120,800	16.34	6,266	15.92
55-64 years	1,174,503	12.31	735,741	13.31	93,912	12.70	4,672	11.87
65-74 years	696,839	7.30	441,691	7.99	56,647	7.66	2,841	7.22
75-84 years	358,137	3.75	227,574	4.12	29,162	3.95	1,043	2.65
85+ years	134,198	1.41	87,077	1.58	9,775	1.32	265	0.67
Total	9,541,801		5,526,757		739,210		39,357	
Females								
00-14 years	1,713,000	16.91	977,049	17.08	134,252	17.61	6,759	17.21
15-24 years	1,347,017	13.30	781,348	13.66	97,991	12.86	5,266	13.41
25-34 years	1,412,404	13.94	647,527	11.32	82,416	10.81	4,379	11.15
35-44 years	1,289,116	12.72	683,939	11.96	98,353	12.90	5,875	14.96
45-54 years	1,449,302	14.31	865,542	15.13	124,067	16.28	6,284	16.00
55-64 years	1,289,273	12.73	771,881	13.50	98,773	12.96	4,734	12.05
65-74 years	841,129	8.30	504,179	8.81	66,911	8.78	3,351	8.53
75-84 years	505,689	4.99	309,077	5.40	39,945	5.24	1,776	4.52
85+ years	284,443	2.81	179,132	3.13	19,455	2.55	859	2.19
Total	10,131,373		5,719,674		762,163		39,283	
Race								
White alone	12,704,637	64.58	9,056,423	80.53	1,215,341	80.95	68,730	87.40
Black alone	3,070,392	15.61	1,004,795	8.93	115,040	7.66	3,513	4.47
American Indian, Alaskan Native alone	74,793	0.38	42,003	0.37	3,100	0.21	281	0.36
Asian alone	1,570,223	7.98	430,929	3.83	56,776	3.78	3,183	4.05
Other race alone	1,692,250	8.60	419,072	3.73	74,747	4.98	1,672	2.13
Two or more races	560,879	2.85	293,209	2.61	36,369	2.42	1,261	1.60

Characteristic	New York State		NYS excl. NYC		Suffolk County		CFS study area*	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	19,673,174		11,246,431		1,501,373		78,640	
Ethnicity								
Hispanic	3,619,658	18.40	1,182,361	10.51	267,396	17.81	12,358	15.71
Non-Hispanic	16,053,516	81.60	10,064,070	89.49	1,233,977	82.19	66,282	84.29
Total	19,673,174		11,246,431		1,501,373		78,640	
Type of Occupied Housing								
Owner	3,894,722	53.63	2,903,372	69.98	392,390	79.46	20,312	82.24
Renter	3,367,557	46.37	1,245,372	30.02	101,459	20.54	4,385	17.76
Total	7,262,279		4,148,744		493,849		24,697	
Group Quarters								
In Group Quarters	579,255	2.94	403,613	3.59	32,009	2.13	450	0.57
Total	19,673,174		11,246,431		1,501,373		78,640	
Education Level, Age 25+								
No High School Diploma	1,930,117	14.37	789,988	10.35	102,990	10.07	4,501	8.49
High School/College Diploma	11,505,678	85.63	6,844,483	89.65	919,980	89.93	48,516	91.51
Total	13,435,795		7,634,471		1,022,970		53,017	
Place of Birth								
New York State	12,476,545	63.42	8,400,219	74.69	1,146,002	76.33	62,923	80.01
Other US State	2,291,057	11.65	1,389,560	12.36	105,301	7.01	4,778	6.08
Native Born Outside US	482,831	2.45	172,080	1.53	22,746	1.52	1,257	1.60
Foreign Born	4,422,741	22.48	1,284,572	11.42	227,324	15.14	9,682	12.31
Total	19,673,174		11,246,431		1,501,373		78,640	
Residence 1 Year Ago, Age 1+								
Same House	17,327,735	89.08	9,899,376	88.93	1,385,030	93.16	72,984	93.95
Different House	2,123,539	10.92	1,232,713	11.07	101,653	6.84	4,697	6.05
Total	19,451,274		11,132,089		1,486,683		77,681	
Poverty Status								
Above Poverty	16,158,091	84.31	9,576,765	88.09	1,368,345	92.98	73,454	93.85
Below Poverty	3,005,943	15.69	1,295,071	11.91	103,269	7.02	4,814	6.15
Total	19,164,034		10,871,836		1,471,614		78,268	

Source of data: 2011-2015 American Community Survey 5-year estimates from the US Census

*Data are for 15 entire census tracts, including block groups that are not in the study area

Table 1c. Sociodemographics of the Centereach/Farmingville/Selden study area by individual census tract

Characteristic	Census Tract 1581.04 Number	Percent	Census Tract 1581.10 Number	Percent	Census Tract 1581.11 Number	Percent	Census Tract 1581.12 Number	Percent	Census Tract 1581.16 Number	Percent
Population:										
Males:										
00-14 years	586	21.06	465	23.93	346	20.44	439	20.33	182	20.00
15-24 years	320	11.50	283	14.57	266	15.71	381	17.65	144	15.82
25-34 years	360	12.94	248	12.76	216	12.76	332	15.38	108	11.87
35-44 years	472	16.97	255	13.12	172	10.16	330	15.28	109	11.98
45-54 years	388	13.95	315	16.21	332	19.61	233	10.79	170	18.68
55-64 years	333	11.97	177	9.11	194	11.46	286	13.25	129	14.18
65-74 years	218	7.84	113	5.82	94	5.55	112	5.19	36	3.96
75-84 years	87	3.13	81	4.17	66	3.90	46	2.13	6	0.66
85+ years	18	0.65	6	0.31	7	0.41	0	0.00	26	2.86
Total	2,782		1,943		1,693		2,159		910	
Females:										
00-14 years	411	14.62	179	10.55	336	18.77	370	17.00	134	13.14
15-24 years	515	18.32	249	14.68	266	14.86	331	15.21	181	17.75
25-34 years	275	9.78	262	15.45	234	13.07	308	14.15	75	7.35
35-44 years	469	16.68	241	14.21	193	10.78	261	11.99	142	13.92
45-54 years	532	18.93	350	20.64	244	13.63	259	11.90	193	18.92
55-64 years	300	10.67	214	12.62	254	14.19	326	14.98	120	11.76
65-74 years	165	5.87	155	9.14	139	7.77	216	9.93	81	7.94
75-84 years	79	2.81	46	2.71	83	4.64	95	4.37	84	8.24
85+ years	65	2.31	0	0.00	41	2.29	10	0.46	10	0.98
Total	2,811		1,696		1,790		2,176		1,020	
Race:										
White alone	4,888	87.39	3,420	93.98	3,216	92.33	3,743	86.34	1,368	70.88
Black alone	174	3.11	0	0.00	98	2.81	158	3.64	141	7.31
Am.Indian, Alaskan Native alone	50	0.89	0	0.00	0	0.00	42	0.97	0	0.00
Asian alone	325	5.81	124	3.41	36	1.03	302	6.97	304	15.75
Other race alone	58	1.04	59	1.62	133	3.82	10	0.23	117	6.06
Two or more races	98	1.75	36	0.99	0	0.00	80	1.85	0	0.00
Total	5,593		3,639		3,483		4,335		1,930	
Ethnicity:										
Hispanic	548	9.80	533	14.65	568	16.31	897	20.69	252	13.06
Non-Hispanic	5,045	90.20	3,106	85.35	2,915	83.69	3,438	79.31	1,678	86.94
Total	5,593		3,639		3,483		4,335		1,930	
Type of Occupied Housing:										
Owner	1,615	92.92	970	92.82	929	92.44	972	78.90	655	95.20
Renter	123	7.08	75	7.18	76	7.56	260	21.10	33	4.80
Total	1,738		1,045		1,005		1,232		688	
Group Quarters:										
In Group Quarters	0	0.00	0	0.00	0	0.00	19	0.44	10	0.52
Total	5,593		3,639		3,483		4,335		1,930	
Education Level, Age 25+:										
No High School Diploma	221	5.88	261	10.60	149	6.57	412	14.64	84	6.52
High School/College Diploma	3,540	94.12	2,202	89.40	2,120	93.43	2,402	85.36	1,205	93.48
Total	3,761		2,463		2,269		2,814		1,289	
Place of Birth:										
New York State	4,593	82.12	3,240	89.04	3,038	87.22	3,427	79.05	1,444	74.82
Other US State	244	4.36	242	6.65	143	4.11	223	5.14	136	7.05
Native Born Outside US	74	1.32	18	0.49	12	0.34	14	0.32	6	0.31
Foreign Born	682	12.19	139	3.82	290	8.33	671	15.48	344	17.82
Total	5,593		3,639		3,483		4,335		1,930	
Residence 1 Year Ago, Age 1+:										
Same House	5,321	96.12	3,520	97.59	3,254	94.29	3,960	91.52	1,826	95.85
Different House	215	3.88	87	2.41	197	5.71	367	8.48	79	4.15
Total	5,536		3,607		3,451		4,327		1,905	
Poverty Status:										
Above Poverty	5,403	96.60	3,495	96.04	3,326	95.91	3,796	88.20	1,709	88.87
Below Poverty	190	3.40	144	3.96	142	4.09	508	11.80	214	11.13
Total	5,593		3,639		3,468		4,304		1,923	

Characteristic	Census Tract 1585.07 Number	Percent	Census Tract 1585.08 Number	Percent	Census Tract 1585.09 Number	Percent	Census Tract 1585.10 Number	Percent	Census Tract 1585.11 Number	Percent
Population:										
Males:										
00-14 years	334	17.08	699	20.05	334	14.03	775	22.43	479	13.00
15-24 years	458	23.42	647	18.55	392	16.47	289	8.36	716	19.43
25-34 years	158	8.08	315	9.03	458	19.24	668	19.33	548	14.87
35-44 years	215	10.99	492	14.11	369	15.50	429	12.42	531	14.41
45-54 years	380	19.43	585	16.78	383	16.09	573	16.58	645	17.50
55-64 years	250	12.78	400	11.47	255	10.71	442	12.79	351	9.53
65-74 years	105	5.37	301	8.63	177	7.44	163	4.72	290	7.87
75-84 years	39	1.99	32	0.92	12	0.50	106	3.07	93	2.52
85+ years	17	0.87	16	0.46	0	0.00	10	0.29	32	0.87
Total	1,956		3,487		2,380		3,455		3,685	
Females:										
00-14 years	295	14.95	504	17.42	456	18.63	571	16.66	668	21.07
15-24 years	322	16.32	350	12.09	283	11.56	369	10.77	437	13.78
25-34 years	176	8.92	319	11.02	325	13.28	688	20.08	293	9.24
35-44 years	255	12.92	445	15.38	364	14.87	527	15.38	452	14.25
45-54 years	459	23.26	569	19.66	508	20.75	431	12.58	509	16.05
55-64 years	206	10.44	317	10.95	227	9.27	547	15.96	455	14.35
65-74 years	109	5.52	319	11.02	146	5.96	191	5.57	246	7.76
75-84 years	118	5.98	71	2.45	118	4.82	76	2.22	72	2.27
85+ years	33	1.67	0	0.00	21	0.86	27	0.79	39	1.23
Total	1,973		2,894		2,448		3,427		3,171	
Race:										
White alone	3,470	88.32	5,861	91.85	4,191	86.81	6,125	89.00	6,049	88.23
Black alone	38	0.97	162	2.54	312	6.46	5	0.07	96	1.40
Am.Indian, Alaskan Native alone	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Asian alone	243	6.18	240	3.76	180	3.73	224	3.25	220	3.21
Other race alone	66	1.68	42	0.66	136	2.82	332	4.82	410	5.98
Two or more races	112	2.85	76	1.19	9	0.19	196	2.85	81	1.18
Total	3,929		6,381		4,828		6,882		6,856	
Ethnicity:										
Hispanic	700	17.82	825	12.93	1,053	21.81	864	12.55	1,472	21.47
Non-Hispanic	3,229	82.18	5,556	87.07	3,775	78.19	6,018	87.45	5,384	78.53
Total	3,929		6,381		4,828		6,882		6,856	
Type of Occupied Housing:										
Owner	1,049	91.86	1,684	92.88	917	58.67	2,012	89.14	1,740	88.69
Renter	93	8.14	129	7.12	646	41.33	245	10.86	222	11.31
Total	1,142		1,813		1,563		2,257		1,962	
Group Quarters:										
In Group Quarters	48	1.22	21	0.33	0	0.00	28	0.41	7	0.10
Total	3,929		6,381		4,828		6,882		6,856	
Education Level, Age 25+:										
No High School Diploma	257	10.20	269	6.43	475	14.12	386	7.91	361	7.92
High School/College Diploma	2,263	89.80	3,912	93.57	2,888	85.88	4,492	92.09	4,195	92.08
Total	2,520		4,181		3,363		4,878		4,556	
Place of Birth:										
New York State	2,920	74.32	5,423	84.99	3,784	78.38	5,773	83.89	5,502	80.25
Other US State	274	6.97	194	3.04	196	4.06	428	6.22	334	4.87
Native Born Outside US	47	1.20	187	2.93	60	1.24	131	1.90	92	1.34
Foreign Born	688	17.51	577	9.04	788	16.32	550	7.99	928	13.54
Total	3,929		6,381		4,828		6,882		6,856	
Residence 1 Year Ago, Age 1+:										
Same House	3,683	94.22	6,064	95.11	4,315	90.80	6,545	96.15	5,994	88.15
Different House	226	5.78	312	4.89	437	9.20	262	3.85	806	11.85
Total	3,909		6,376		4,752		6,807		6,800	
Poverty Status:										
Above Poverty	3,756	96.23	6,221	97.75	4,185	86.90	6,342	92.30	6,596	96.21
Below Poverty	147	3.77	143	2.25	631	13.10	529	7.70	260	3.79
Total	3,903		6,364		4,816		6,871		6,856	

Characteristic	Census Tract 1586.06 Number	Percent	Census Tract 1581.03 Number	Percent	Census Tract 1581.15 Number	Percent	Census Tract 1586.05 Number	Percent	Census Tract 1587.04 Number	Percent
Population:										
Males:										
00-14 years	416	17.05	431	19.28	787	24.40	547	20.38	954	22.08
15-24 years	409	16.76	462	20.66	325	10.07	303	11.29	429	9.93
25-34 years	232	9.51	231	10.33	393	12.18	254	9.46	445	10.30
35-44 years	334	13.69	369	16.50	429	13.30	507	18.89	693	16.04
45-54 years	485	19.88	301	13.46	515	15.96	524	19.52	437	10.11
55-64 years	253	10.37	288	12.88	364	11.28	200	7.45	750	17.36
65-74 years	201	8.24	107	4.79	191	5.92	232	8.64	501	11.59
75-84 years	90	3.69	47	2.10	124	3.84	117	4.36	97	2.24
85+ years	20	0.82	0	0.00	98	3.04	0	0.00	15	0.35
Total	2,440		2,236		3,226		2,684		4,321	
Females:										
00-14 years	387	16.70	451	19.38	613	15.57	462	18.36	922	19.29
15-24 years	279	12.04	353	15.17	646	16.41	206	8.19	479	10.02
25-34 years	222	9.58	172	7.39	280	7.11	229	9.10	521	10.90
35-44 years	451	19.46	363	15.60	590	14.99	533	21.18	589	12.32
45-54 years	318	13.72	411	17.66	430	10.92	379	15.06	692	14.48
55-64 years	250	10.79	341	14.65	379	9.63	280	11.13	518	10.84
65-74 years	230	9.92	80	3.44	331	8.41	304	12.08	639	13.37
75-84 years	86	3.71	108	4.64	416	10.57	100	3.97	224	4.69
85+ years	95	4.10	48	2.06	251	6.38	23	0.91	196	4.10
Total	2,318		2,327		3,936		2,516		4,780	
Race:										
White alone	4,370	91.85	3,977	87.16	6,284	87.74	4,510	86.73	7,258	79.75
Black alone	19	0.40	361	7.91	282	3.94	255	4.90	1,412	15.51
Am.Indian, Alaskan Native alone	11	0.23	0	0.00	118	1.65	60	1.15	0	0.00
Asian alone	238	5.00	115	2.52	386	5.39	185	3.56	61	0.67
Other race alone	58	1.22	74	1.62	0	0.00	9	0.17	168	1.85
Two or more races	62	1.30	36	0.79	92	1.28	181	3.48	202	2.22
Total	4,758		4,563		7,162		5,200		9,101	
Ethnicity:										
Hispanic	660	13.87	974	21.35	324	4.52	649	12.48	2,039	22.40
Non-Hispanic	4,098	86.13	3,589	78.65	6,838	95.48	4,551	87.52	7,062	77.60
Total	4,758		4,563		7,162		5,200		9,101	
Type of Occupied Housing:										
Owner	1,203	82.57	1,122	81.66	1,659	76.17	1,423	89.78	2,362	64.57
Renter	254	17.43	252	18.34	519	23.83	162	10.22	1,296	35.43
Total	1,457		1,374		2,178		1,585		3,658	
Group Quarters:										
In Group Quarters	121	2.54	39	0.85	108	1.51	7	0.13	42	0.46
Total	4,758		4,563		7,162		5,200		9,101	
Education Level, Age 25+:										
No High School Diploma	320	9.79	241	8.41	220	4.59	127	3.45	718	11.37
High School/College Diploma	2,947	90.21	2,625	91.59	4,571	95.41	3,555	96.55	5,599	88.63
Total	3,267		2,866		4,791		3,682		6,317	
Place of Birth:										
New York State	3,714	78.06	3,560	78.02	5,894	82.30	4,384	84.31	6,227	68.42
Other US State	310	6.52	201	4.40	683	9.54	295	5.67	875	9.61
Native Born Outside US	67	1.41	179	3.92	34	0.47	54	1.04	282	3.10
Foreign Born	667	14.02	623	13.65	551	7.69	467	8.98	1,717	18.87
Total	4,758		4,563		7,162		5,200		9,101	
Residence 1 Year Ago, Age 1+:										
Same House	4,573	96.89	4,354	97.01	6,803	97.13	4,884	94.83	7,888	89.14
Different House	147	3.11	134	2.99	201	2.87	266	5.17	961	10.86
Total	4,720		4,488		7,004		5,150		8,849	
Poverty Status:										
Above Poverty	4,237	91.16	4,137	91.16	6,817	96.53	5,047	97.06	8,387	92.34
Below Poverty	411	8.84	401	8.84	245	3.47	153	2.94	696	7.66
Total	4,648		4,538		7,062		5,200		9,083	

Source of data: 2011-2015 American Community Survey 5-year estimates from the US Census
Data are for 15 entire census tracts, including block groups that are not in the study area

Table 1d. Observed and expected number of cancer cases, 2011-2015, Centereach/Farmingville/Selden Study Area, Suffolk County, with expected numbers of cases calculated based on two standards

Site	CFS study area	NYS Standard			NYS excl. NY Standard		
	Observed	Expected[1]	Ratio[2]	95% CI[3]	Expected[1]	Ratio[2]	95% CI[3]
Lung/bronchus	**311**	**199.3**	***1.56**	**(1.39,1.74)**	**222.0**	***1.40**	**(1.25,1.57)**
Urinary Bladder (including in situ)	**112**	**74.8**	***1.50**	**(1.23,1.80)**	**86.3**	***1.30**	**(1.07,1.56)**
Thyroid	**98**	**68.5**	***1.43**	**(1.16,1.74)**	**67.3**	***1.46**	**(1.18,1.77)**
Leukemia	**87**	**53.1**	***1.64**	**(1.31,2.02)**	**57.7**	***1.51**	**(1.21,1.86)**

[1]Expected values are based on standard rates for the given comparison area for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Observed/Expected

[3]Confidence intervals (CI) calculated by the method of Sahai and Khurshid (1993, 1996).

* Significant difference between observed and expected at the p < 0.05 level (two-sided).

Lung Cancer

Table 2a-1. Observed and expected number of lung cancer cases, by sex and broad age group, Centereach/Farmingville/Selden Study Area, Suffolk County, 2011-2015

Age group	Males				Females			
	Observed	Expected[1]	Ratio[2]	95% CI[3]	Observed	Expected[1]	Ratio[2]	95% CI[3]
0 -19 years	0	0.0	0.00		0	0.0	0.00	
20 -49 years	8	4.7	1.72	(0.73,3.35)	8	5.7	1.41	(0.61,2.77)
50-64 years	35	34.0	1.03	(0.72-1.43)	42	36.0	1.17	(0.84,1.58)
65+ years	**111**	**69.5**	***1.60**	**(1.31,1.92)**	**107**	**72.2**	***1.48**	**(1.21,1.79)**
All ages	**154**	**108.2**	***1.42**	**(1.21,1.67)**	**157**	**113.9**	***1.38**	**(1.17,1.61)**

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Observed/Expected

[3]Confidence intervals (CI) calculated by the method of Sahai and Khurshid (1993, 1996).

* Significant difference between observed and expected at the p < 0.05 level (two-sided).

Table 2a-2. Lung cancer incidence by time period, Suffolk County, New York State excluding New York City, and New York State, 1996-2000 to 2011-2015

Area	1996-2000			2001-2005			2006-2010			2011-2015		
	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]
NYS	12780.8	67.6	67.0-68.1	13028.2	65.2	64.7-65.7	13561.8	64.5	64.0-65.0	13737.4	60.2	59.8-60.7
NYS excl. NYC	8548.8	73.8	73.1-74.5	8855.4	72.5	71.8-73.2	9319.8	72.0	71.3-72.6	9449.0	67.2	66.6-67.9
Suffolk County	986.8	74.0	71.9-76.1	1098.2	74.6	72.6-76.6	1196.4	74.5	72.6-76.4	1194.4	66.7	65.0-68.5

Source of data: New York State Cancer Registry

[1]Rates are per 100,000 persons, age adjusted to the 2000 US population.

[2]95% confidence interval, calculated by the Fay and Feuer method with the Tiwari et al. modification.

Table 2a-3 Observed and expected numbers of lung cancer cases by time period, ZIP Code and sex, ZIP Codes approximating the CFS Study Area, Suffolk County, New York, 1993-2003

Period	ZIP Codes	Males				Females				Both			
		obs	exp[1]	ratio[2]	range	obs	exp[1]	ratio[2]	range	obs	exp[1]	ratio[2]	range
1993-1997													
	11720	47	37.1	1.27	15-49% above	37	26.8	1.38	15-49% above*	84	63.9	1.31	15-49% above
	11738	27	19.8	1.36	15-49% above	16	13.9	1.15	15-49% above	43	33.7	1.28	15-49% above
	11784	47	33.2	1.42	15-49% above	25	24.4	1.02	within 15%	72	57.6	1.25	15-49% above
	total	121	90.1	1.34	15-49% above	78	65.1	1.20	15-49% above	199	155	1.28	15-49% above
1999-2003													
	11720	52	43.2	1.20	15-49% above	45	36.5	1.23	15-49% above	97	79.7	1.22	15-49% above
	11738	25	23.5	1.06	within 15%	24	17.9	1.34	15-49% above	49	41.4	1.18	15-49% above
	11784	41	33.5	1.22	15-49% above	42	29.9	1.40	15-49% above	83	63.4	1.31	15-49% above
	total	118	100	1.18	15-49% above	111	84.3	1.32	15-49% above	229	185	1.24	15-49% above

[1]Expected values are based on standard rates for New York State for the given time period.

[2]Observed/expected

*in area of elevated incidence, not likely due to chance

Table 2a-4. Observed and expected numbers of lung cancer cases by type of lung cancer, males and females combined, Centereach/Farmingville/Selden Study Area, Suffolk County, 2011-2015

Type	Observed	Expected[1]	Observed/Expected	95% confidence interval[2]
Small cell lung cancer	**44**	**27.0**	***1.63**	**(1.18,2.19)**
Non-small cell lung cancer				
Squamous cell carcinoma	52	45.0	1.16	(0.86,1.51)
Adenocarcinoma	**147**	**101.8**	***1.44**	**(1.22,1.70)**
Large cell carcinoma	17	12.7	1.34	(0.78,2.14)

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).

* Significant difference between observed and expected at the p < 0.05 level (two-sided).

Table 2a-5. Lung cancer stage at time of diagnosis by year, Centereach/Farmingville/Selden study area and New York State excluding New York City, 2006-2015

Summary Stage	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Centereach/Farmingville/Selden study area																				
Local	8	16.7	11	20.8	14	26.9	14	29.2	18	33.3	11	16.9	18	31.6	9	14.5	14	24.6	20	28.6
Regional	9	18.8	12	22.6	8	15.4	10	20.8	12	22.2	19	29.2	10	17.5	16	25.8	17	29.8	22	31.4
Distant	30	62.5	24	45.3	28	53.9	19	39.6	24	44.4	31	47.7	24	42.1	31	50.0	23	40.4	27	38.6
Unknown	1	2.1	6	11.3	2	3.9	5	10.4	0	0.0	4	6.2	5	8.8	6	9.7	3	5.3	1	1.4
NYS excl. NYC																				
Local	1,770	19.2	1,788	19.4	1,997	21.0	1,991	21.2	2,015	21.7	2,067	21.9	2,020	21.5	2,093	22.1	2,120	23.0	2,442	25.1
Regional	2,086	22.6	2,129	23.1	2,127	22.4	2,063	22.0	2,133	23.0	2,088	22.1	2,206	23.5	2,139	22.6	2,093	22.7	2,149	22.1
Distant	4,135	44.8	4,035	43.9	4,368	46.0	4,406	46.9	4,342	46.7	4,515	47.9	4,497	47.8	4,506	47.6	4,383	47.5	4,549	46.8
Unknown	1,231	13.4	1,249	13.6	1,006	10.6	930	9.9	803	8.6	766	8.1	678	7.2	728	7.7	626	6.8	579	6.0

Source of data: New York State Cancer Registry

Bladder Cancer

Table 2b-1. Observed and expected number of bladder cancer cases, by sex and broad age group, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Age group	Males and Females			
	Observed	Expected[1]	Observed/Expected	95% confidence interval[2]
0 -19 years	0	0.0	0.00	
20 -49 years	7	4.4	1.58	(0.64,3.28)
50-64 years	29	23.6	1.23	(0.82,1.76)
65+ years	**76**	**58.2**	***1.31**	**(1.03,1.63)**
All ages	**112**	**86.3**	***1.30**	**(1.07,1.56)**
Males	**83**	**63.9**	***1.30**	**(1.03,1.61)**
Females	29	22.4	1.30	(0.87,1.86)

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).

***** Significant difference between observed and expected at the p < 0.05 level (two-sided).

Table 2b-2. Bladder cancer incidence by time period, Suffolk County, New York State excluding New York City, and New York State, 1996-2000 to 2011-2015

Area	1996-2000			2001-2005			2006-2010			2011-2015		
	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]
NYS	4497	23.8	23.4-24.1	4861.8	24.3	24.0-24.6	5042.8	23.9	23.6-24.2	5330.2	23.4	23.1-23.7
NYS excl. NYC	3130.2	27.0	26.6-27.4	3465	28.2	27.8-28.7	3598.8	27.6	27.2-28.0	3834.8	27.3	26.9-27.7
Suffolk County	377.2	28.5	27.2-29.8	441.4	30.2	28.9-31.5	456.2	28.5	27.3-29.7	509.6	28.5	27.4-29.7

Source of data: New York State Cancer Registry

[1]Rates are per 100,000 persons, age adjusted to the 2000 US population.

[2]95% confidence interval, calculated by the Fay and Feuer method with the Tiwari et al. modification

Table 2b-3. Observed and expected numbers of bladder cancer cases by type of bladder cancer, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Type	Males and Females			
	Observed	Expected[1]	Observed/expected	95% confidence interval[2]
Transitional cell	**107**	**82.1**	***1.30**	**(1.07,1.58)**
Squamous cell	1	0.8	1.24	(0.03,6.96)
Adenocarcinoma	1	0.6	1.74	(0.04,9.77)
Other[3]	3	2.9	1.05	(0.22,3.08)

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).

[3]Other includes other specified and unspecified carcinomas, other specified and unspecified malignant neoplasms, and sarcomas.

* Significant difference between observed and expected at the p < 0.05 level (two-sided).

Thyroid Cancer

Table 2c-1. Observed and expected number of thyroid cancer cases, by sex and broad age group, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Age group	Males and Females			
	Observed	Expected[1]	Observed/expected	95% confidence interval[2]
0 -19 years	**50**	**34.0**	***1.47**	**(1.09,1.94)**
20 -49 years	26	22.3	1.17	(0.76,1.71)
50-64 years	**22**	**11.0**	***1.99**	**(1.25,3.03)**
65+ years	**98**	**67.3**	***1.46**	**(1.18,1.77)**
All ages	**32**	**17.5**	***1.83**	**(1.25,2.58)**
Males	**66**	**49.8**	***1.32**	**(1.02,1.69)**
Females	**50**	**34.0**	***1.47**	**(1.09,1.94)**

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).

* Significant difference between observed and expected at the p < 0.05 level (two-sided).

Table 2c-2. Thyroid cancer incidence by time period, males and females combined, Suffolk County, New York State excluding New York City, and New York State, 1996-2000 to 2011-2015

Area	1996-2000			2001-2005			2006-2010			2011-2015		
	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]
NYS	1414.8	7.5	7.3-7.6	2073.2	10.5	10.3-10.7	3277.6	16.3	16.0-16.5	4152.6	19.9	19.6-20.2
NYS excl. NYC	879.4	7.9	7.7-8.2	1281.4	11.2	10.9-11.5	1924.4	16.4	16.1-16.8	2339.2	19.6	19.2-19.9
Suffolk County	126.8	9.0	8.3-9.7	200.0	13.2	12.4-14.0	304.0	19.3	18.3-20.3	383.2	23.7	22.6-24.8

Source of data: New York State Cancer Registry
[1]Rates are per 100,000 persons, age adjusted to the 2000 US population.
[2]95% confidence interval, calculated by the Fay and Feuer method with the Tiwari et al. modification

Table 2c-3. Observed and expected numbers of thyroid cancer cases, by type, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Type	Males and Females			
	Observed	Expected[1]	Observed/Expected	95% confidence interval[2]
Papillary	**91**	**61.8**	***1.47**	**(1.19,1.81)**
Follicular	0	2.2	0	(. ,1.68)
Medullary	3	1.0	2.91	(0.62,8.77)
Anaplastic	0	0.3	0	(. ,12.30)
Other	4	2.0	2.00	(0.54,5.12)

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females
[2]Confidence intervals were calculated by the method of Sahai and Khursid (1993, 1996).
***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

Table 2c-4. Observed and expected number of thyroid cancer cases by tumor size, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Tumor size	Males and Females			
	Observed	Expected[1]	Observed/Expected	95% confidence interval[2]
0 cm	0	0.12	0.00	(. ,30.74)
0.1 - 1.0 cm	**46**	**26.52**	***1.73**	**(1.27,2.31)**
1.1 - 2.0 cm	29	19.75	1.47	(0.98,2.11)
2.1 + cm	21	17.78	1.18	(0.73,1.81)
Unknown	2	3.13	0.64	(0.08,2.31)
Total	**98**	**67.30**	***1.46**	**(1.18,1.77)**

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).

***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

Table 2c-5. Stage of Disease at the time of diagnosis, thyroid cancer cases, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, Compared with New York State excluding New York City, 2011-2015

Stage	CFS Study Area		NYS, excluding NYC	
	Number	Percent	Number	Percent
Local	65	66.3	7,688	65.7
Regional	30	30.6	3,313	28.3
Distant	1	1.0	302	2.6
Unknown	2	2.0	392	3.4
Total	98	100.0	11,695	100.0

Source of data: New York State Cancer Registry

Leukemia

Table 2d-1. Observed and expected number of leukemia cases, by age group, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Age group	Males and Females			
	Observed	Expected[1]	Observed/expected	95% confidence interval[2]
0 -19 years	**11**	**3.7**	***2.96**	**(1.48,5.32)**
20 -49 years	10	7.8	1.29	(0.61,2.36)
50-64 years	18	16.5	1.09	(0.65,1.72)
65+ years	**48**	**29.8**	***1.61**	**(1.19,2.14)**
All ages	**87**	**57.7**	***1.51**	**(1.21,1.86)**
Males	**53**	**33.7**	***1.57**	**(1.18,2.06)**
Females	34	24.1	1.41	(0.98,1.97)

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).

***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

Table 2d-2. Leukemia incidence by time period, Suffolk County, New York State excluding New York City, and New York State, 1996-2000 to 2011-2015

Area	1996-2000			2001-2005			2006-2010			2011-2015		
	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]	Avg Ann Cases	Rate[1]	95% CI[2]
NYS	2560.4	13.6	13.3-13.8	2799.4	14.1	13.9-14.3	3092.4	15.0	14.7-15.2	3562.4	16.1	15.9-16.4
NYS excl. NYC	1674.8	14.6	14.3-14.9	1871.8	15.6	15.2-15.9	2058.6	16.3	16.0-16.6	2369.2	17.6	17.3-18.0
Suffolk County	193.0	14.5	13.6-15.4	242.8	16.6	15.7-17.6	270.2	16.9	16.0-17.9	347.0	20.2	19.2-21.2

Source of data: New York State Cancer Registry

[1]Age adjusted to the 2000 US population

[2]95% confidence interval, calculated by the Fay and Feuer method with the Tiwari et al. modification

Table 2d-3. Numbers of leukemia cases diagnosed in the Centereach/Farmingville/Selden study area by single year, 2006-2015

	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of cases	7	13	9	10	13	11	17	15	23	21

Source of data: New York State Cancer Registry

Table 2d-4. Observed and expected numbers of leukemia cases, by leukemia subtype, Centereach/Farmingville/Selden Study Area, Suffolk County, 2011-2015

Subtype	Males and Females			
	Observed	Expected[1]	Observed/expected	95% confidence interval[2]
ALL	**15**	**5.2**	***2.89**	**1.61-4.76**
CLL	**36**	**23.8**	***1.51**	**1.06-2.09**
AML	17	15.5	1.09	0.64-1.76
CML	12	7.3	1.65	0.85-2.87

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females

[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).

*****Significant difference between observed and expected at the p < 0.05 level (two-sided).

Behavioral/Lifestyle/Medical care

A. Tobacco

Table 3a-1: Tobacco use/history (five years) in unique individuals admitted to or visiting a hospital, Centereach/Farmingville/Selden study area, Suffolk County, New York State excluding New York City, and New York State, 2011-2015

Region		NYS		NYS excl. NYC		Suffolk County		CFS study area	
Total population[1]		19,378,102		11,202,969		1,493,350		64,413	
	age group (years)	Rate	95% CI[2]	Rate	95% CI[2]	Rate	95% CI[2]	Rate	95% CI[2]
Tobacco use/history (five years) in persons (unique individuals) admitted to or visiting a hospital per 100 population	18+	17.4	(17.4,17.4)	21.2	(21.1,21.2)	19.9	(19.8,19.9)	23.9	(23.6,24.3)
	18-49	13.5	(13.4,13.5)	17.5	(17.5,17.5)	14.5	(14.4,14.6)	18.8	(18.3,19.2)
	50-64	19.7	(19.7,19.7)	21.7	(21.7,21.8)	21.6	(21.5,21.8)	26.4	(25.6,27.1)
	65+	27.3	(27.2,27.3)	31.1	(31.0,31.1)	34.1	(33.9,34.3)	41.4	(40.2,42.5)
Tobacco use/history per 100 visits/admissions	50-64	16.8	(16.8,16.9)	19.8	(19.7,19.8)	20.6	(20.4,20.7)	25.9	(25.2,26.7)
	65+	22.2	(22.1,22.2)	25.8	(25.7,25.8)	29.4	(29.2,29.6)	35.6	(34.6,36.7)
Hospital visits per 100 person-years (population)	50-64	23.4	(23.4,23.4)	22.0	(22.0,22.0)	21.1	(21.0,21.1)	20.4	(20.0,20.7)
	65+	24.6	(24.6,24.6)	24.1	(24.1,24.1)	23.2	(23.1,23.3)	23.2	(22.8,23.7)

Source of data: New York Statewide Planning and Research Cooperative System (SPARCS)
[1]2010 US Census
[2]95% CI were calculated using the Clopper-Pearson (exact) method

B. Obesity

Table 3b-1. Percent Obese and Obese or Overweight, Persons age 18 and over, Centereach/Farmingville/Selden study area compared with Suffolk County and New York State excluding New York City

Area	Obese		Obese or overweight	
	Percent	95% CI	Percent	95% CI
Centereach/Farmingville/Selden study area*	44.5	26.2, 62.8	76.7	60.9, 92.5
Suffolk County	27.1	23.4, 30.8	62.9	58.9, 66.9
New York State excluding New York City	27.2	26.4, 28.0	63.0	62.0, 64.0

Source of data: 2013-2014 eBRFSS and 2016 BRFSS
*approximated by ZIP Codes 11720, 11738 and 11784

Table 3b-2. Percent with an indicator of obesity, unique individuals admitted to or visiting a hospital, Centereach/Farmingville/Selden study area, Suffolk County, New York State excluding New York City, and New York State, 2011-2015

Region		NYS		NYS excl. NYC		Suffolk County		CFS study area	
Total population[1]		19,378,102		11,202,969		1,493,350		64,413	
	age group (years)	Rate	95% CI[2]	Rate	95% CI[2]	Rate	95% CI[2]	Rate	95% CI[2]
Obesity in persons (unique individuals) admitted to or visiting a hospital per 100 population	5+	6.7	(6.7,6.8)	6.5	(6.5,6.5)	6.0	(6.0,6.1)	7.6	(7.4,7.9)
	21+	8.0	(7.9,8.0)	8.0	(8.0,8.1)	7.6	(7.5,7.6)	9.6	(9.3,9.9)
	5-20	2.4	(2.4,2.5)	1.3	(1.3,1.4)	1.0	(1.0,1.0)	1.3	(1.1,1.5)
	21-49	6.0	(6.0,6.0)	5.8	(5.8,5.9)	5.2	(5.2,5.3)	6.7	(6.4,7.0)
	50-64	10.1	(10.0,10.1)	9.8	(9.8,9.9)	9.5	(9.4,9.6)	12.2	(11.6,12.8)
	65 +	10.8	(10.8,10.9)	11.2	(11.2,11.3)	11.5	(11.4,11.7)	16.1	(15.3,17.0)
Obesity per 100 visits/admissions	50-64	8.6	(8.6,8.6)	8.9	(8.9,9.0)	9.0	(8.9,9.1)	12.0	(11.4,12.6)
	65+	8.8	(8.8,8.8)	9.3	(9.3,9.3)	9.9	(9.8,10.1)	13.9	(13.2,14.7)

Source of data: New York Statewide Planning and Research Cooperative System (SPARCS)
[1]2010 US Census
[2]95% CI were calculated using the Clopper-Pearson (exact) method

C. Occupation

Table 3c-1. Occupation for the civilian employed population 16 years and over, New York State, New York State excluding New York City, and Centereach/Farmingville/Selden study area, 2011-2015

Occupation	NYS		NYS exc. NYC		Suffolk County		CFS study area*	
	Total M&F		Total M&F		Total M&F		Total M&F	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Civilian employed population 16 years and over	9,254,578		5,324,727		735,010		40,142	
Management, business, science, and arts occupations								
Management, business, and financial occupations								
Management occupations	891,755	9.64	519,460	9.76	72,211	9.82	3,848	9.59
Business and financial operations occupations	472,107	5.10	249,045	4.68	33,794	4.60	1,635	4.07
Computer, engineering, and science occupations								
Computer and mathematical occupations	213,778	2.31	118,674	2.23	14,451	1.97	884	2.20
Architecture and engineering occupations	124,825	1.35	88,758	1.67	11,828	1.61	619	1.54

Occupation	NYS		NYS exc. NYC		Suffolk County		CFS study area*	
	Total M&F		Total M&F		Total M&F		Total M&F	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Life, physical, and social science occupations	79,913	0.86	46,627	0.88	5,482	0.75	206	0.51
Education, legal, community service, arts, and media occupations								
Community and social services occupations	186,735	2.02	107,475	2.02	11,506	1.57	517	1.29
Legal occupations	161,759	1.75	80,594	1.51	11,017	1.50	356	0.89
Education, training, and library occupations	664,350	7.18	416,371	7.82	58,620	7.98	2,728	6.80
Arts, design, entertainment, sports, and media occupations	284,477	3.07	98,915	1.86	13,554	1.84	502	1.25
Healthcare practitioner and technical occupations								
Health diagnosing & treating practitioners, other technical occupations	392,210	4.24	249,411	4.68	32,918	4.48	1,547	3.85
Health technologists and technicians	156,047	1.69	103,329	1.94	12,730	1.73	823	2.05
Service occupations								
Healthcare support occupations	323,412	3.49	136,864	2.57	19,379	2.64	1,149	2.86
Firefighting and prevention, other protective service workers incl. supervisors	142,878	1.54	69,149	1.30	10,179	1.38	737	1.84
Law enforcement workers including supervisors	118,955	1.29	81,872	1.54	13,210	1.80	757	1.89
Food preparation and serving related occupations	514,919	5.56	280,406	5.27	33,276	4.53	1,832	4.56
Building and grounds cleaning and maintenance occupations	387,264	4.18	206,396	3.88	28,768	3.91	1,315	3.28
Personal care and service occupations	392,035	4.24	198,486	3.73	23,816	3.24	1,369	3.41
Sales and office occupations								
Sales and related occupations	976,258	10.55	573,308	10.77	85,580	11.64	4,942	12.31
Office and administrative support occupations	1,222,703	13.21	729,408	13.70	103,539	14.09	6,941	17.29
Natural resources, construction, and maintenance occupations								
Farming, fishing, and forestry occupations	23,041	0.25	20,238	0.38	1,370	0.19	19	0.05
Construction and extraction occupations	418,702	4.52	254,011	4.77	43,710	5.95	2,342	5.83
Installation, maintenance, and repair occupations	231,555	2.50	157,568	2.96	24,003	3.27	1,335	3.33
Production, transportation, and material moving occupations								
Production occupations	362,614	3.92	253,903	4.77	30,420	4.14	1,310	3.26
Transportation occupations	353,781	3.82	180,913	3.40	26,433	3.60	1,733	4.32
Material moving occupations	158,505	1.71	103,546	1.94	13,216	1.80	696	1.73

Derived from Census table S2401: OCCUPATION BY SEX FOR THE CIVILIAN EMPLOYED POPULATION 16 YEARS AND OVER

*Data are for 15 entire census tracts, including block groups that are not in the study area

Table 3c-2: Industry for the Civilian Employed Population 16 Years and Over, New York State, New York State excluding New York City, and Centereach/Farmingville/Selden Study area, 2011-2015

Industry	NYS		NYS exc. NYC		Suffolk County		CFS study area*	
	Total M&F		Total M&F		Total M&F		Total M&F	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Civilian employed population 16 years and over	9,254,578		5,324,727		735,010		40,142	
Agriculture, forestry, fishing and hunting	48,085	0.52	44,199	0.83	3,063	0.42	52	0.13
Mining, quarrying, and oil and gas extraction	6,408	0.07	5,867	0.11	139	0.02	18	0.04
Construction	514,033	5.55	321,689	6.04	56,754	7.72	2,941	7.33
Manufacturing	600,408	6.49	453,329	8.51	56,176	7.64	2,796	6.97
Wholesale trade	229,075	2.48	139,826	2.63	23,627	3.21	1,530	3.81
Retail trade	1,000,895	10.82	612,173	11.50	86,646	11.79	5,530	13.78
Transportation and warehousing, and utilities	472,856	5.11	239,569	4.50	38,785	5.28	2,464	6.14
Information	270,734	2.93	121,209	2.28	19,689	2.68	1,152	2.87
Finance and insurance, and real estate and rental and leasing	744,556	8.05	362,207	6.80	52,092	7.09	2,459	6.13
Services:								
Professional, scientific, and management, and administrative and waste management services	1,059,499	11.45	546,934	10.27	81,343	11.07	3,842	9.57
Educational services, and health care and social assistance	2,540,670	27.45	1,502,811	28.22	194,694	26.49	10,602	26.41
Arts, entertainment, and recreation, and accommodation and food services	875,623	9.46	447,798	8.41	53,431	7.27	2,935	7.31
Other services, except public administration	465,436	5.03	247,616	4.65	32,679	4.45	1,510	3.76
Public administration	426,300	4.61	279,500	5.25	35,892	4.88	2,311	5.76

Derived from Census table S2403: INDUSTRY BY SEX FOR THE CIVILIAN EMPLOYED POPULATION 16 YEARS AND OVER
*Data are for 15 entire census tracts, including block groups that are not in the study area

References

Sahai H, Khurshid A (1993). Confidence Intervals for the Mean of a Poisson Distribution: A Review. *Biometrical J*, 35: 857-67.

Sahai H, Khurshid A (1996). *Statistics in Epidemiology: Methods, Techniques, and Applications*. Boca Raton, FL: CRC Press, Inc.

Clopper CJ and Pearson ES (1934) The use of confidence or fiducial limits illustrated in the case of the binomial, *Biometrica 26*(4): 404-413.

Tiwari RC, Clegg LX, Zou Z. Efficient interval estimation for age-adjusted cancer rates. *Stat Methods Med Res* 2006 Dec;15(6):547-69.

Appendix 3: Environmental Data

A. Long term time trends for criteria air pollutant concentrations for Suffolk County monitoring locations

Figure 1. Centereach/Farmingville/Selden (Suffolk County) nitrogen dioxide annual average (There is not currently a NAAQS based on annual-averages)

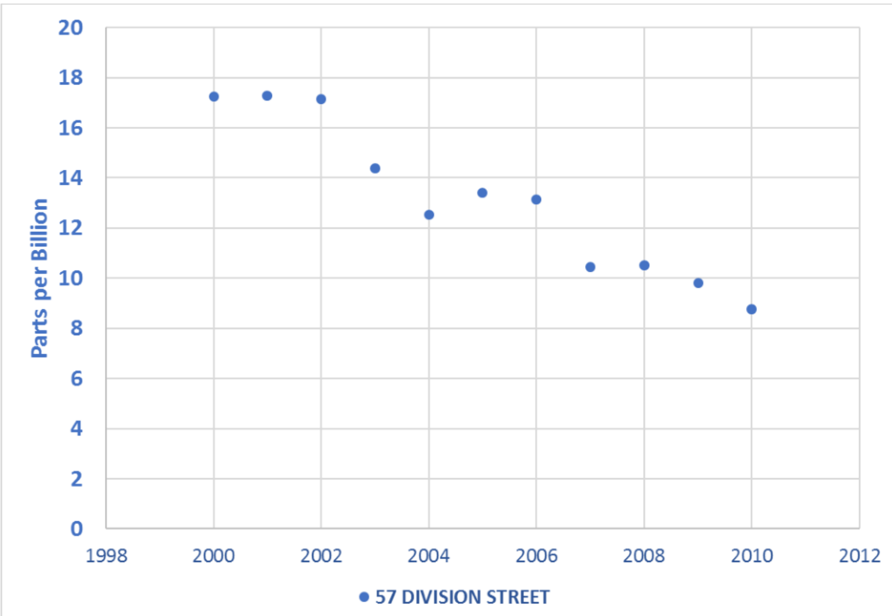


Figure 2. Centereach/Farmingville/Selden (Suffolk County) sulfur dioxide annual average. (There is not currently a NAAQS based on annual-averages)

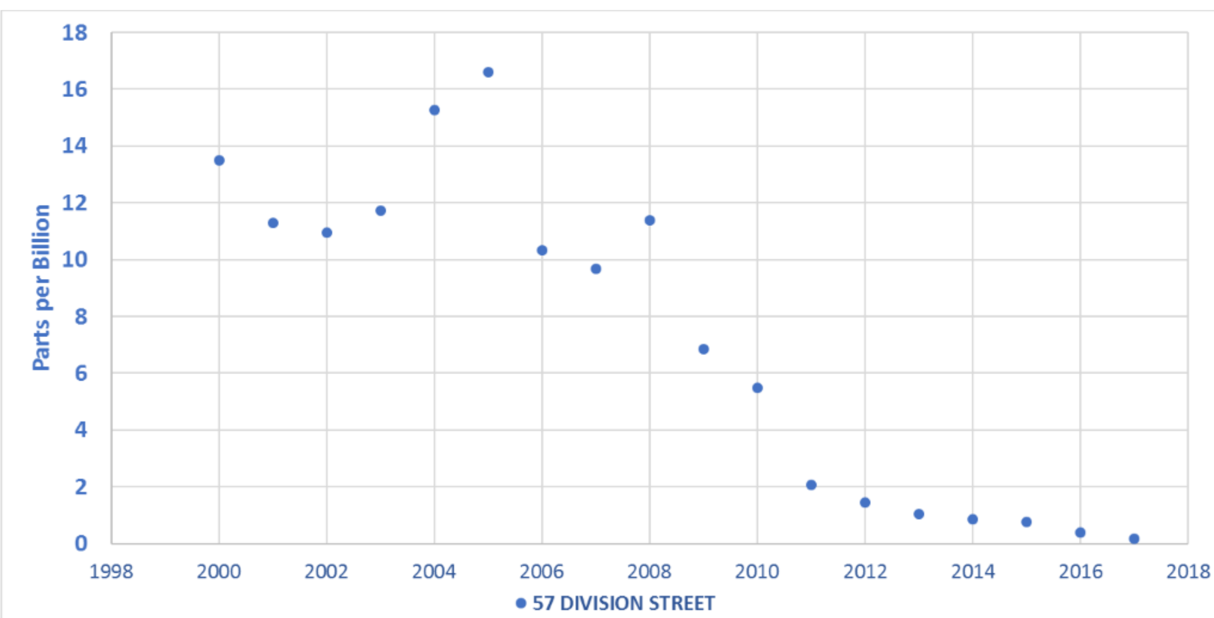
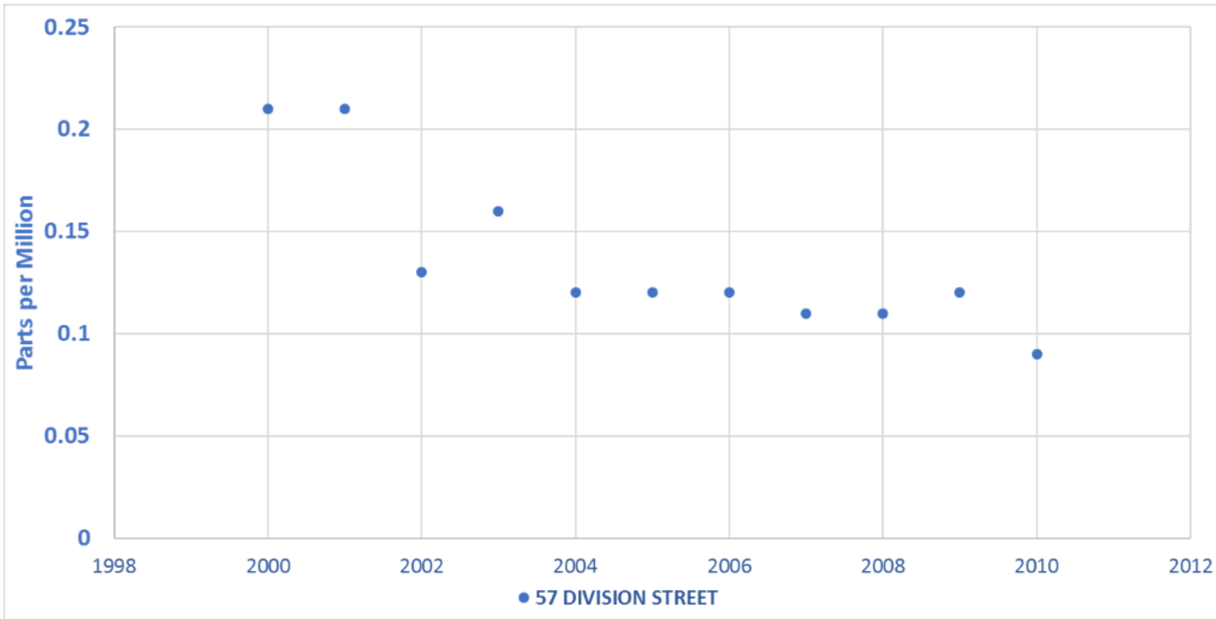


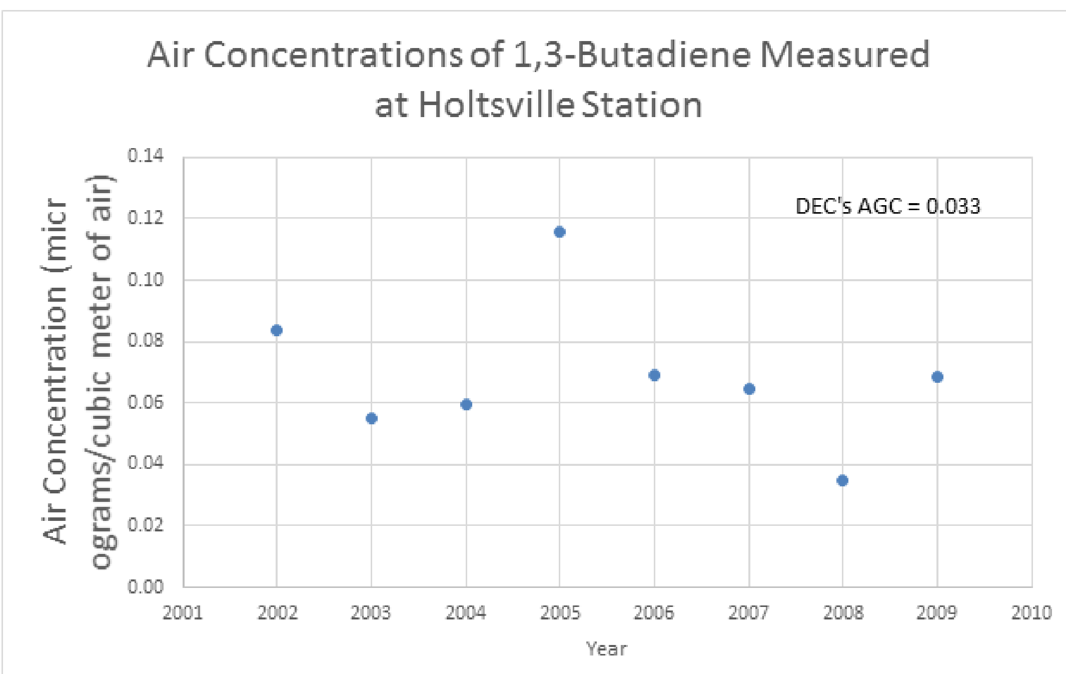
Figure 3. Centereach/Farmingville/Selden (Suffolk County) carbon monoxide annual average. (There is not currently a NAAQS based on annual-averages)



B. Trends and toxicological information for air toxics measured in Holtsville

1,3-Butadiene

Figure 1. Trends in 1,3-butadiene concentrations measured in Holtsville



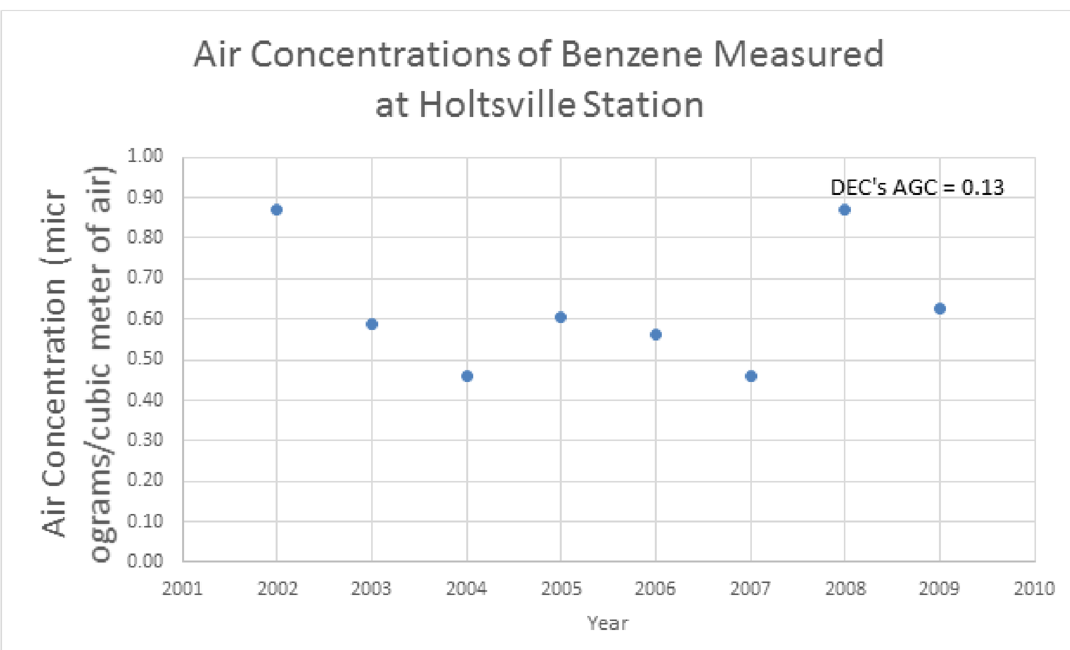
According to the Toxicological Profile for 1,3-butadiene published by the Agency for Toxic Substances and Disease Registry (ATSDR), 1,3-butadiene is released from industrial sources, automobile exhaust, cigarette smoke and the burning of wood and rubber/plastic[1].

The EPA, 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[1]. Animal studies provide additional evidence of carcinogenicity. 1,3-Butadiene is associated with several non-cancer effects as well.

The annual average concentrations of 1,3-butadiene across New York's monitoring network in 2017 ranged from 0.013 to 0.069 micrograms per cubic meter of air (mcg/m^3) and for many monitors the annual average was above DEC's health-based AGC (0.033 mcg/m^3). In 2009, the average across all monitors was 0.082 mcg/m^3 with a range of 0.039 – 0.15 mcg/m^3. The 1,3-butadiene air concentrations measured at Holtsville are within this range which suggests the area is not unusual given the amount of urbanization and density of roadways. DEC's AGC is based on the air concentration associated with a one-in-one-million excess cancer risk for long-term exposure. Therefore, the measured levels of 1,3-butadiene are estimated to pose a low risk of cancer over a lifetime.

Benzene

Figure 2. Trends in benzene concentrations measured in Holtsville



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[2]. 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 that 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^3). Benzene levels indoors are usually higher than outdoors[2].

Benzene has been classified as a known human carcinogen by NTP, EPA 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 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.

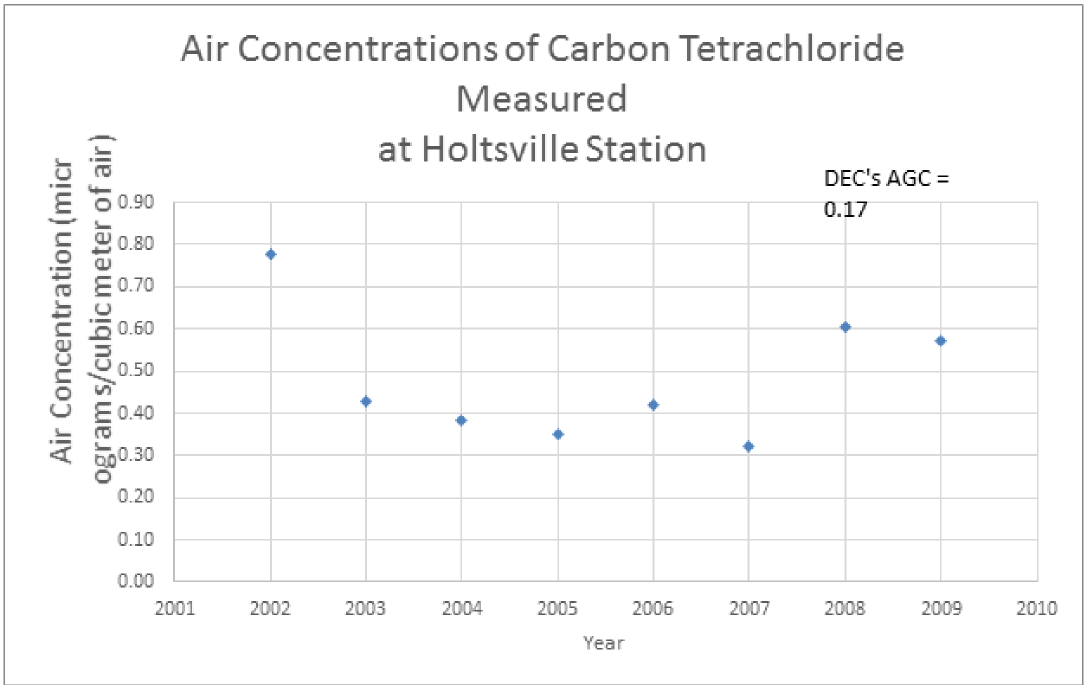
The annual average concentrations of benzene across New York's monitoring network in 2017 ranged from 0.22 to 0.89 mcg/m^3 which is above DEC's health-based AGC (0.13 mcg/m^3). In 2009, the average across all monitors was 0.76 mcg/m^3 with a range of 0.25 – 1.1 mcg/m^3. The benzene air concentrations measured at Holtsville are within this range which suggests the area is not unusual given the amount of urbanization and density of roadways. DEC's AGC is based on the air concentration associated with a one-in-one-million excess cancer risk for long-term exposure. Therefore, the measured levels of benzene are estimated to pose a low risk of cancer over a lifetime.

Carbon Tetrachloride

Carbon tetrachloride is an industrial chemical that does not occur naturally. According to 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[3].

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[3]. High levels of exposure to carbon tetrachloride in air causes an increased incidence of liver tumors in animal studies[3]. As such, the EPA, 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.

Figure 3. Trends in carbon tetrachloride concentrations measured in Holtsville



The annual average concentrations of carbon tetrachloride across New York's monitoring network in 2017 ranged from 0.49 to 0.51 mcg/m³ and all monitoring averages were above DEC's health-based AGC (0.17 mcg/m³). In 2009, the average across all monitors was 0.57 mcg/m³ with a range of 0.51 – 0.69 mcg/m³. The carbon tetrachloride air concentrations measured at Holtsville are within this range. Although the measured levels exceed DEC's AGC, 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. Additionally, the concentrations for this area would not be considered unusual as carbon tetrachloride is no longer released and measured concentrations reflect global circulation of this pollutant with a long atmospheric half-life.

<u>References</u>

1. ATSDR (Agency for Toxic Substances and Disease Registry). 2012. Toxicological Profile for 1,3-Butadiene. US Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, GA: September 2012. Available at https://www.atsdr.cdc.gov/toxprofiles/tp28.pdf.
2. ATSDR (Agency for Toxic Substances and Disease Registry). 2007, 2015. Toxicological Profile for Benzene. US Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, GA: August 2007. Available at https://www.atsdr.cdc.gov/toxprofiles/tp3.pdf and 2015 Addendum https://www.atsdr.cdc.gov/toxprofiles/Benzene_Addendum.pdf.
3. ATSDR (Agency for Toxic Substances and Disease Registry). 2005. Toxicological Profile for Carbon Tetrachloride. US Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, GA: August 2005. Available at https://www.atsdr.cdc.gov/toxprofiles/tp30.pdf.

C. Drinking water tables for the Public Water System in the CFS study area

Table 1. List of analytes

Principal Organic Compounds (POCs)	
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	TRICHLOROFLUOROMETHANE
CIS-1,3-DICHLOROPROPENE	VINYL CHLORIDE
DIBROMOMETHANE	XYLENE, META AND PARA
DICHLORODIFLUOROMETHANE	XYLENES, TOTAL
Nitrates (NITs)	
NITRATE	NITRITE
NITRATE-NITRITE	
Primary Inorganic Compounds (PICs)	
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	
Synthetic Organic Compounds (SOCs)	
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	
Radiological Samples (RADs)	
COMBINED RADIUM (-226 & -228)	RADIUM-228
GROSS ALPHA PARTICLE ACTIVITY	THORIUM
GROSS BETA PARTICLE ACTIVITY	URANIUM
RADIUM-226	
Disinfection by Products (DBP9)	
TOTAL HALOACETIC ACIDS (HAA5)	TOTAL TRIHALOMETHANES (TTHM)
Lead and Copper (PBCU)	
COPPER	LEAD

Table 2. Primary inorganic compound exceedances in the Public Water System for the Centereach/Farmingville/Selden study area

Community	Sample Site	Analyte	Sample Result (mg/L)	MCL (mg/L)	Date
Coram	McDonald's	Iron + Manganese	0.657	0.500	7/29/1999
Coram	McDonald's	Iron (Fe)	0.657	0.300	7/29/1999
Coram	McDonald's	Iron + Manganese	0.511	0.500	1/10/2000
Coram	McDonald's	Iron (Fe)	0.488	0.300	1/10/2000
Coram	Burger King	Iron (Fe)	0.404	0.300	3/16/2000
Coram	Burger King	Iron + Manganese	0.537	0.500	5/16/2000
Coram	Burger King	Iron (Fe)	0.503	0.300	5/16/2000
Coram	Burger King	Iron + Manganese	0.651	0.500	6/15/2000

Community	Sample Site	Analyte	Sample Result (mg/L)	MCL (mg/L)	Date
Coram	Burger King	Iron (Fe)	0.612	0.300	6/15/2000
Coram	Burger King	Iron (Fe)	0.410	0.300	7/17/2000
Coram	Burger King	Iron + Manganese	0.918	0.500	8/22/2000
Coram	Burger King	Iron (Fe)	0.890	0.300	8/22/2000
Coram	Burger King	Iron (Fe)	0.860	0.300	9/27/2000
Coram	Burger King	Iron + Manganese	0.894	0.500	9/27/2000
Coram	Burger King	Iron + Manganese	0.889	0.300	10/25/2000
Coram	Burger King	Iron + Manganese	0.974	0.500	11/15/2000
Coram	Burger King	Iron (Fe)	0.940	0.300	11/15/2000
Coram	Burger King	Iron (Fe)	0.782	0.300	12/27/2000
Coram	Burger King	Iron + Manganese	0.809	0.500	12/27/2000
Coram	Burger King	Iron (Fe)	0.858	0.300	1/16/2001
Coram	Burger King	Iron + Manganese	0.887	0.500	1/16/2001
Coram	Burger King	Iron + Manganese	0.888	0.500	2/8/2001
Coram	Burger King	Iron (Fe)	0.849	0.300	2/8/2001
Coram	Burger King	Iron (Fe)	0.749	0.300	3/29/2001
Coram	Burger King	Iron + Manganese	0.778	0.500	3/29/2001
Coram	McDonald's	Iron (Fe)	0.855	0.300	5/23/2001
Coram	McDonald's	Iron + Manganese	0.886	0.500	5/23/2001
Coram	Burger King	Iron (Fe)	0.470	0.300	6/21/2001
Coram	Burger King	Iron (Fe)	1.020	0.300	7/18/2001
Coram	Burger King	Iron + Manganese	1.044	0.500	7/18/2001
Coram	Burger King	Iron (Fe)	0.466	0.300	8/23/2001
Coram	Burger King	Iron (Fe)	0.426	0.300	9/19/2001
Coram	Burger King	Iron (Fe)	0.410	0.300	7/8/2002
Centereach	Middle Country Library	Iron + Manganese	1.157	0.500	12/9/2003
Centereach	Middle Country Library	Iron (Fe)	1.150	0.300	12/9/2003
Coram	Coram Fire Department	Iron + Manganese	0.585	0.500	1/6/2004
Coram	Coram Fire Department	Iron (Fe)	0.570	0.300	1/6/2004
Lake Ronkonkoma	McDonalds	Iron (Fe)	0.320	0.300	5/27/2004
Coram	Burger King	Iron + Manganese	0.889	0.500	9/15/2004
Coram	Burger King	Iron (Fe)	0.860	0.300	9/15/2004
Coram	Burger King	Iron (Fe)	0.810	0.300	10/4/2004
Coram	Burger King	Iron + Manganese	0.837	0.500	10/4/2004
Farmingville	Farmingville H.D. Office	Iron (Fe)	0.440	0.300	6/13/2005
Farmingville	Farmingville H.D. Office	Iron (Fe)	0.330	0.300	8/8/2005
Farmingville	Farmingville H.D. Office	Iron + Manganese	0.600	0.500	5/4/2006
Farmingville	Farmingville H.D. Office	Iron (Fe)	0.570	0.300	5/4/2006
Farmingville	Farmingville H.D. Office	Iron + Manganese	0.659	0.500	6/12/2006
Farmingville	Farmingville H.D. Office	Iron (Fe)	0.650	0.300	6/12/2006
Farmingville	Farmingville H.D. Office	Iron (Fe)	0.330	0.300	7/6/2006

Community	Sample Site	Analyte	Sample Result (mg/L)	MCL (mg/L)	Date
Coram	Coram Fire Department	Iron (Fe)	0.600	0.300	7/14/2009
Coram	Coram Fire Department	Iron + Manganese	0.622	0.500	7/14/2009
Coram	Burger King	Iron (Fe)	1.100	0.300	7/8/2010
Coram	Burger King	Iron + Manganese	1.157	0.500	7/8/2010
Coram	McDonald's	Iron (Fe)	0.340	0.300	7/22/2013
Coram	McDonald's	Iron (Fe)	1.100	0.300	9/22/2014
Coram	McDonald's	Iron + Manganese	1.135	0.500	9/22/2014

Table 3. Lead and copper exceedances for the Public Water System in the CFS study area

Community	Sample Site	Analyte	Sample Result (mg/L)	Maximum Contaminant Level (mg/L)	Sample Date
Farmingville	Dunkin Donuts	Copper (Cu)	2.184	1.300	4/1/2013
Farmingville	Dunkin Donuts	Lead (Pb)	0.077	0.015	4/1/2013
Coram	Burger King	Lead (Pb)	0.031	0.015	3/4/2003
Coram	Burger King	Lead (Pb)	0.016	0.015	6/13/2005

Table 4. List of 30 contaminants in the 3rd Unregulated Contaminant Monitoring Rule

Chemicals	
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	17β-estradiol
vanadium	17α-ethynylestradiol (ethinyl estradiol)
molybdenum	16-α-hydroxyestradiol (estriol)
cobalt	equilin
strontium	estrone
total chromium	testosterone
chromium-6	4-androstene-3,17-dione
Viruses	
enteroviruses	noroviruses

D. Private Well Data Review

Private wells are estimated to serve approximately 2% of the households in the CFS study area. The Suffolk County Department of Health Services operates a private well water testing program and there are data available from as far back as 1997 for some private wells in the study area. While not comprehensive for all private wells, the available data were reviewed for this investigation, and findings from this review are presented below. In total, 91 samples returned values that exceeded MCLs, comprising the four analyte groups: Principal Organic Compounds (POCs), Nitrates (NITs), Primary Inorganic Compounds (PICs), and Lead and Copper (PBCU). References in this section to "exceedances" do not represent violations. The findings from this analysis are depicted below.

Principal Organic Compounds (POCs). There were four POC exceedances in private wells out of 750 samples tested since 1997, comprising less than one percent of all samples taken. Three of these exceedances resulted from elevated levels of tetrachloroethene (PCE) and one from 1,1,1-trichloroethane (1,1,1-TCA). No exceedances occurred after the year 1999. Appendix 3D, Table 1 below shows these results. Because less than one percent of private wells tested showed principal organic compound levels that exceed MCLs, principal organic compound exposures from private wells are not expected to have impacted cancer rates in the overall study area or among people served by private wells. Additional information about these chemicals and potential health effects is provided below.

Table 1. Principal organic compound exceedances in private water within the CFS study area

Community	Sample Site	Analyte	Sample Result (mg/L)	Maximum Contaminant Level (mg/L)	Sample Date
Centereach	Residence with private well	Tetrachloroethene	0.006	0.005	3/13/1997
Centereach	Laundry Room of Centereach	Tetrachloroethene	0.009	0.005	12/11/1997
Centereach	Residence with private well	1,1,1 Trichloroethane	0.009	0.005	10/4/1999
Centereach	Residence with private well	Tetrachloroethene	0.008	0.005	10/4/1999

Workplace exposure to high levels of PCE in air is associated with certain forms of cancer. Evidence from human studies also show associations between exposure to high levels of PCE and effects on the nervous system, liver and kidneys, and the reproductive system. These data suggest, but do not prove, that the effects were caused by PCE and not by some other factor or factors. PCE causes cancer in laboratory animals exposed to high levels over their lifetimes. Exposure to high levels of PCE causes behavioral effects and effects on the liver and kidney in laboratory animals. US EPA considers PCE to be "likely to be carcinogenic in humans by all routes of exposure." Some industrial workers exposed to large amounts of 1,1,1-TCA had nervous system, liver and cardiovascular system damage. Exposure to high concentrations of this chemical causes nervous system, liver and cardiovascular system damage in laboratory animals. US EPA indicates that there is inadequate information to assess the carcinogenic potential of 1,1,1-TCA.

Nitrates (NITs). Nitrate exceedances have occurred rarely within the CFS study area. There were four MCL exceedances out of 90 samples for nitrates in private water since 2001, representing 4 percent of all samples taken. After each exceedance, subsequent sampling showed a reduction in analyte levels. Details for these exceedances are provided in Table 2.

Table 2. Nitrate exceedances in private water within the CFS study area

Community	Sample Site	Analyte	Sample Result (mg/L)	Maximum Contaminant Level (mg/L)	Sample Date
Centereach	Residence with private well	Nitrate	11.5	10	7/26/2001
Centereach	Residence with private well	Nitrate	13.2	10	5/6/2008
Centereach	Residence with private well	Nitrate	10.2	10	6/8/2004
Centereach	Residence with private well	Nitrate	13.5	10	5/29/2007

Infants less than six months of age are particularly sensitive to the effects of nitrate. Nitrate is converted to nitrite in the body, and nitrite reduces the ability of the infant's blood to carry oxygen. Symptoms of illness (blue baby syndrome) can develop rapidly and include shortness of breath and blueness of the skin. Human drinking-water exposure to nitrate has not been associated with increased cancer risk.

Primary Inorganic Compounds (PICs). As was the case with SCWA public water samples, sampling of private drinking sources showed exceedances for both iron and iron+manganese. This was the largest group of analyte exceedances for private water, with sporadic exceedances spanning from 1997 to 2015. In total, 226 PIC samples were analyzed, with 36 in exceedance, representing 16 percent of the samples taken for this group. More specific information on these MCL exceedances is provided below in Appendix 3D, Table 3. The MCLs for these compounds are based on taste, odor, and appearance. While the MCLs were exceeded, these compounds were measured at concentrations that are lower than concentrations associated with health effects in humans. Additional information about health effects for these analytes is provided in the prior section on public drinking water.

Table 3. Primary inorganic compounds in private water within the CFS study area

Community	Sample Site	Analyte	Sample Result (mg/L)	Maximum Contaminant Level (mg/L)	Sample Date
Centereach	Residence with private well	Iron (Fe)	0.780	0.300	2/17/2000
Centereach	Residence with private well	Iron + Manganese	0.846	0.500	2/17/2000
Centereach	Residence with private well	Iron (Fe)	0.320	0.300	7/27/2010
Centereach	Residence with private well	Iron (Fe)	0.647	0.300	7/27/2010
Centereach	Residence with private well	Iron + Manganese	1.236	0.500	6/7/2001
Coram	Residence with private well	Iron (Fe)	2.160	0.300	6/7/2001
Coram	Residence with private well	Iron + Manganese	2.201	0.500	6/7/2012
Coram	Residence with private well	Iron (Fe)	0.570	0.300	6/7/2012
Coram	Residence with private well	Iron + Manganese	0.573	0.500	5/21/1997
Coram	Residence with private well	Iron (Fe)	4.290	0.300	5/21/1997
Coram	Residence with private well	Iron + Manganese	4.319	0.500	8/10/2009
Coram	Residence with private well	Iron (Fe)	0.640	0.300	8/10/2009
Coram	Residence with private well	Iron + Manganese	0.674	0.500	11/16/2015

Community	Sample Site	Analyte	Sample Result (mg/L)	Maximum Contaminant Level (mg/L)	Sample Date
Coram	Residence with private well	Iron (Fe)	4.890	0.300	11/16/2015
Coram	Residence with private well	Iron + Manganese	4.966	0.500	5/21/1998
Coram	Residence with private well	Iron (Fe)	0.927	0.300	8/28/2007
Coram	Residence with private well	Iron + Manganese	1.138	0.500	8/28/2007
Coram	Residence with private well	Iron (Fe)	7.930	0.300	8/28/2007
Coram	Residence with private well	Iron + Manganese	7.974	0.500	8/1/2007
Coram	Residence with private well	Iron (Fe)	0.690	0.300	8/1/2007
Coram	Residence with private well	Iron + Manganese	0.794	0.500	2/17/2000
Coram	Residence with private well	Iron (Fe)	2.610	0.300	2/17/2000
Coram	Residence with private well	Iron + Manganese	2.657	0.500	7/27/2010
Coram	Residence with private well	Iron (Fe)	0.510	0.300	7/27/2010
Coram	Residence with private well	Iron + Manganese	0.528	0.500	6/7/2001
Farmingville	Residence with private well	Iron (Fe)	0.390	0.300	6/7/2001
Farmingville	Residence with private well	Iron + Manganese	0.513	0.500	6/7/2012
Lake Ronkonkoma	Residence with private well	Iron (Fe)	7.400	0.300	6/7/2012
Lake Ronkonkoma	Residence with private well	Iron + Manganese	7.678	0.500	5/21/1997
Lake Ronkonkoma	Residence with private well	Iron (Fe)	11.900	0.300	5/21/1997
Lake Ronkonkoma	Residence with private well	Iron + Manganese	12.252	0.500	8/10/2009
Lake Ronkonkoma	Residence with private well	Iron (Fe)	0.319	0.300	8/10/2009
Lake Ronkonkoma	Residence with private well	Iron (Fe)	0.700	0.300	11/16/2015
Lake Ronkonkoma	Residence with private well	Iron + Manganese	0.787	0.500	11/16/2015
Ronkonkoma	Residence with private well	Iron (Fe)	0.720	0.300	8/28/2007
Ronkonkoma	Residence with private well	Iron + Manganese	0.726	0.500	8/28/2007

Lead and Copper (PBCU). Exceedances of lead and copper action levels occurred infrequently within the study area since 1997. There were three exceedances out of 138 PBCU samples, comprising 2 percent of all samples tested, and all were from lead. There have been no action level exceedances for lead and copper since 2000. A more thorough description of these elevated levels is provided below in Appendix 3D, Table 4.

Table 4. Lead and copper exceedances in private water within the CFS study area

Community	Sample Site	Analyte	Sample Result (mg/L)	Maximum Contaminant Level (mg/L)	Sample Date
Centereach	Laundry Room of Centereach	Lead (Pb)	0.091	0.015	12/11/1997
Coram	Residence with private well	Lead (Pb)	0.021	0.015	4/22/1998
Selden	Residence with private well	Lead (Pb)	0.017	0.015	10/23/2000

E. Pesticide Data Analysis and Information

The following figures present the results of analyses of the Pesticide Sales and Use Database. Figure 1 shows the total pounds of solid phase active ingredients applied per square mile and Figures 2a and 2b show the total gallons of liquid phase active ingredients applied per square mile in the two areas. A small number of active ingredients had fewer than 5 gallons per square mile applied over the fourteen-year period and were excluded from further consideration. Figure 3 shows the total grams of solid phase active ingredients applied per household. Figures 4a and 4b shows the total fluid ounces of liquid phase active ingredients applied per household in the two areas. A small number of active ingredients had fewer than 0.5 ounces per household applied over the fourteen-year period and were excluded from further consideration. The greater differences between the two areas in Figures 3 and 4 compared to the differences in Figures 1 and 2 is because the number of households per square mile in the ZIP Code area is 40 percent greater than in the comparison area. Figures 5 through 8 show the amount of each active ingredient applied as a percentage of the total quantities of all the active ingredients applied. The relative quantities of active ingredients applied i n the two areas are similar with the exception that the insecticide trichlorfon makes up a larger percentage of the pounds of active ingredients applied in the comparison area than in the ZIP code area.

Figure 1. Total pounds of solid phase active ingredients commercially applied per square mile, 2000–2013

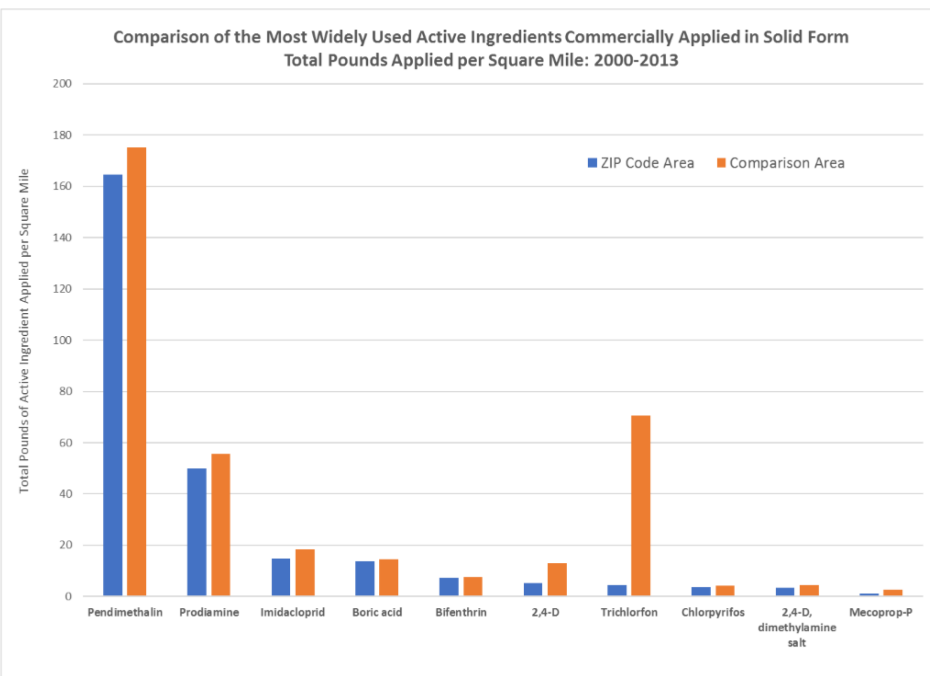


Figure 2a. Total gallons of liquid phase active ingredients commercially applied per square mile, 2000-2013

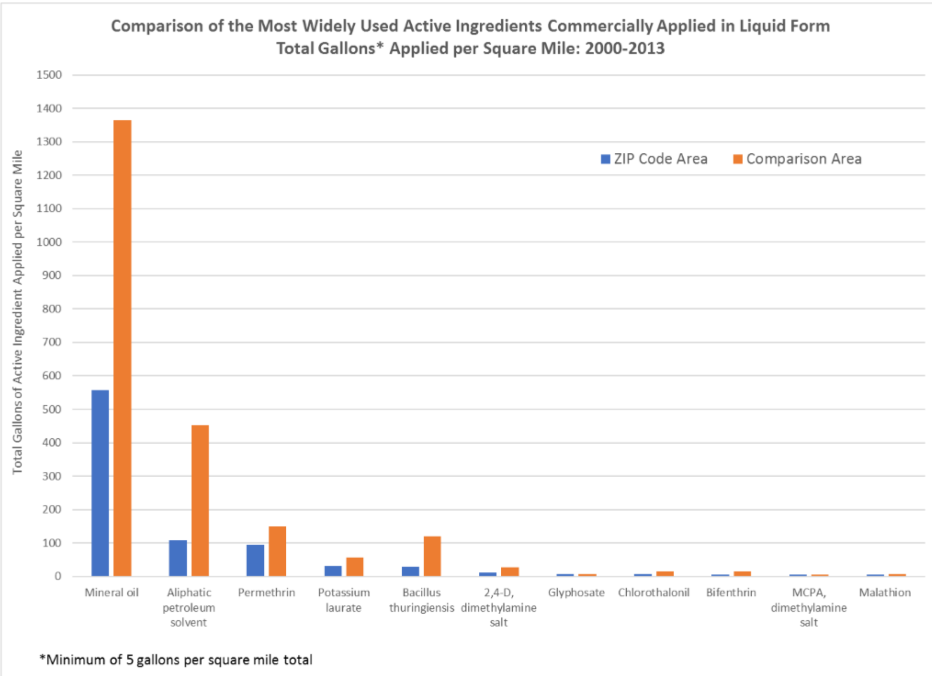


Figure 2b. Total gallons of liquid phase active ingredients commercially applied per square mile, 2000 – 2013. Horticultural oils excluded

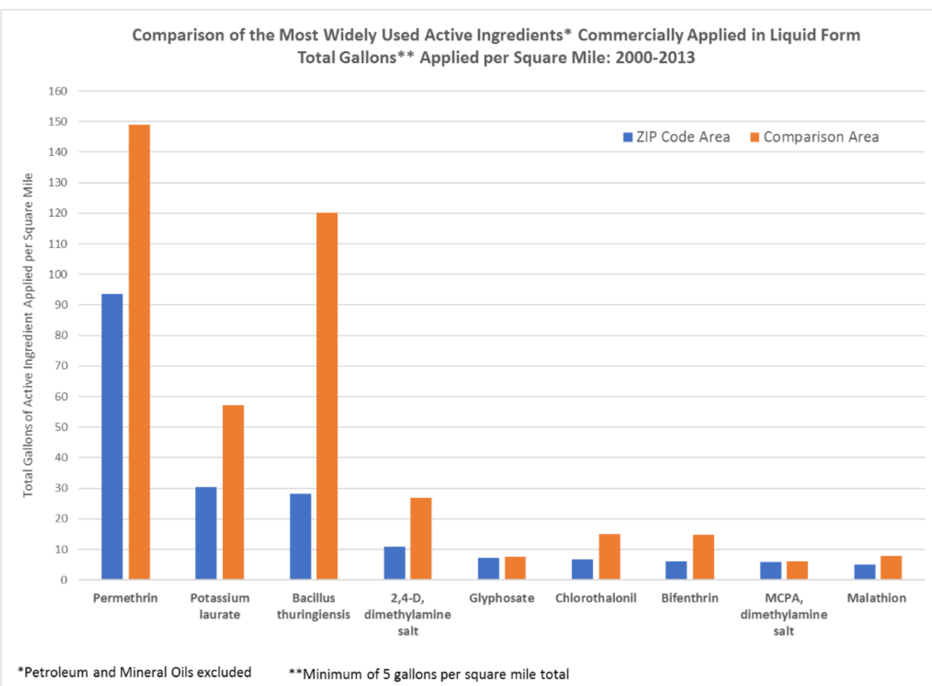


Figure 3. Total grams of solid phase active ingredients commercially applied per household, 2000 – 2013

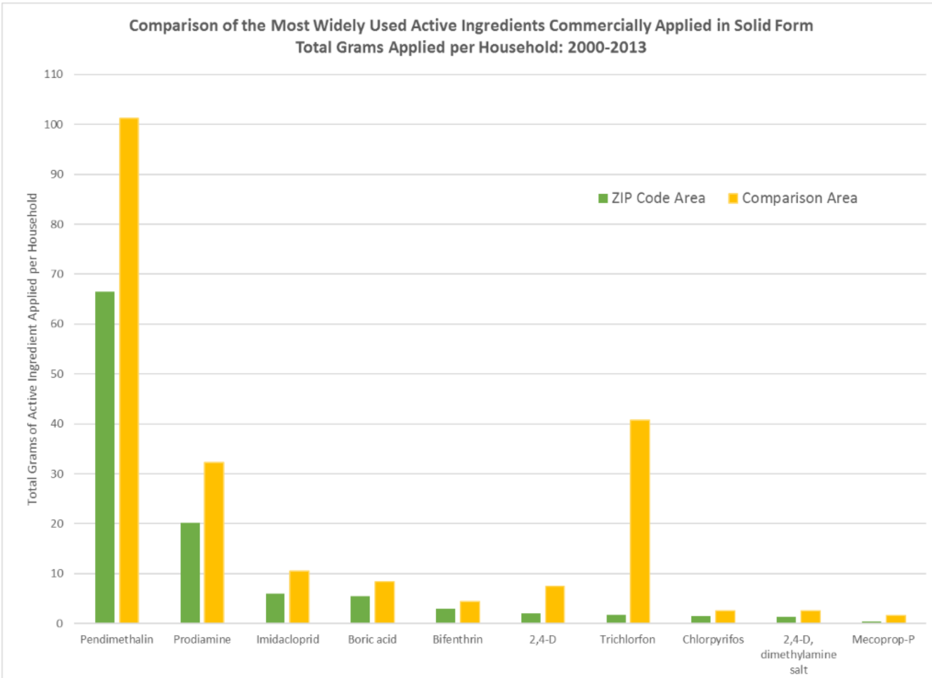


Figure 4a. Total fluid ounces of liquid phase active ingredients commercially applied per household, 2000 – 2013

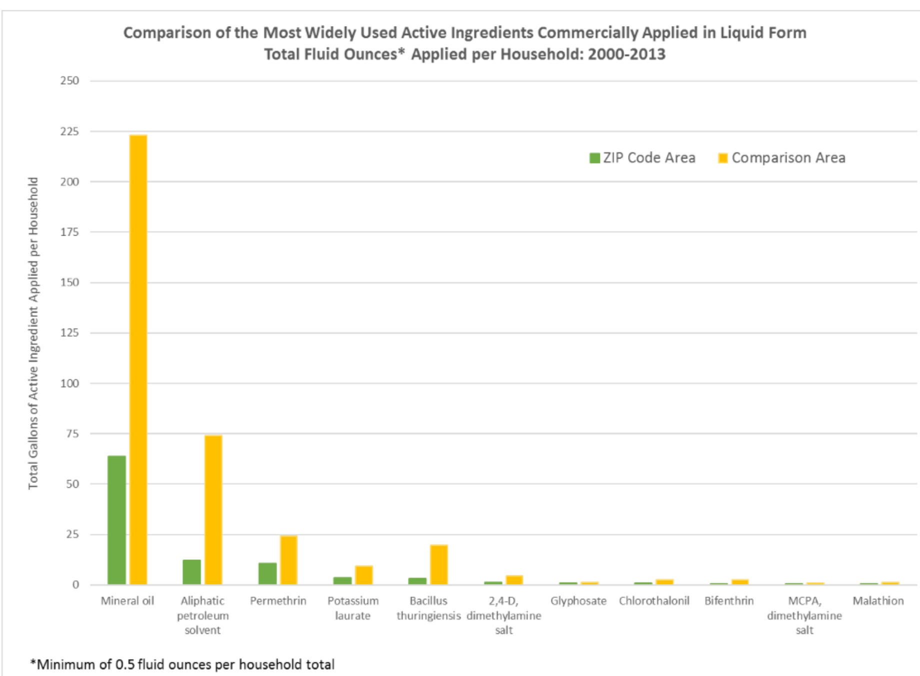


Figure 4b. Total fluid ounces of liquid phase active ingredients commercially applied per household, 2000 – 2013. Horticultural oils excluded

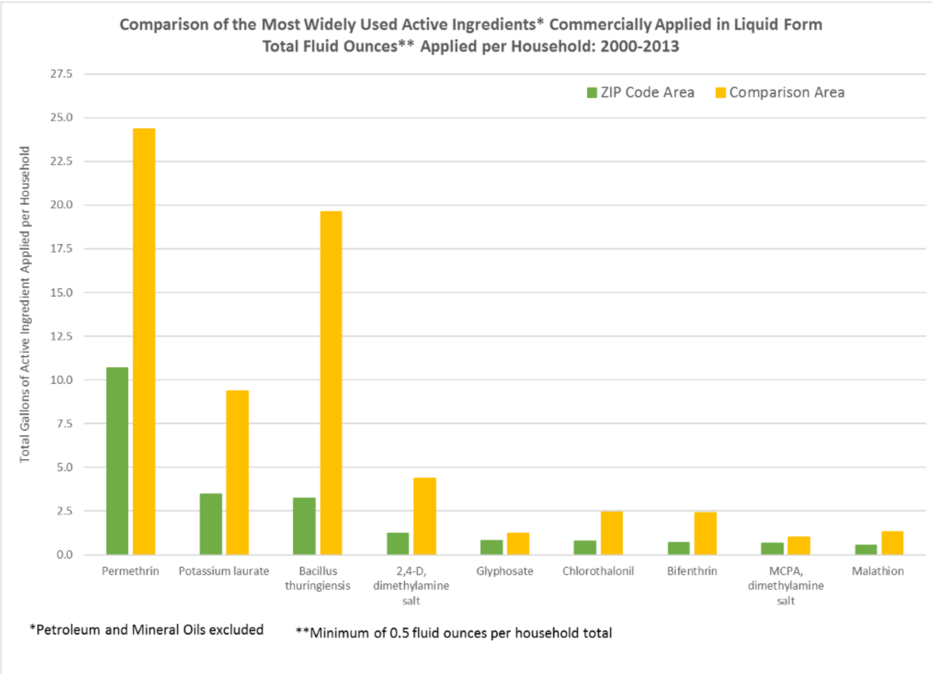


Figure 5. Percentages of liquid phase active ingredients commercially applied in the ZIP Code area, 2000 - 2013.

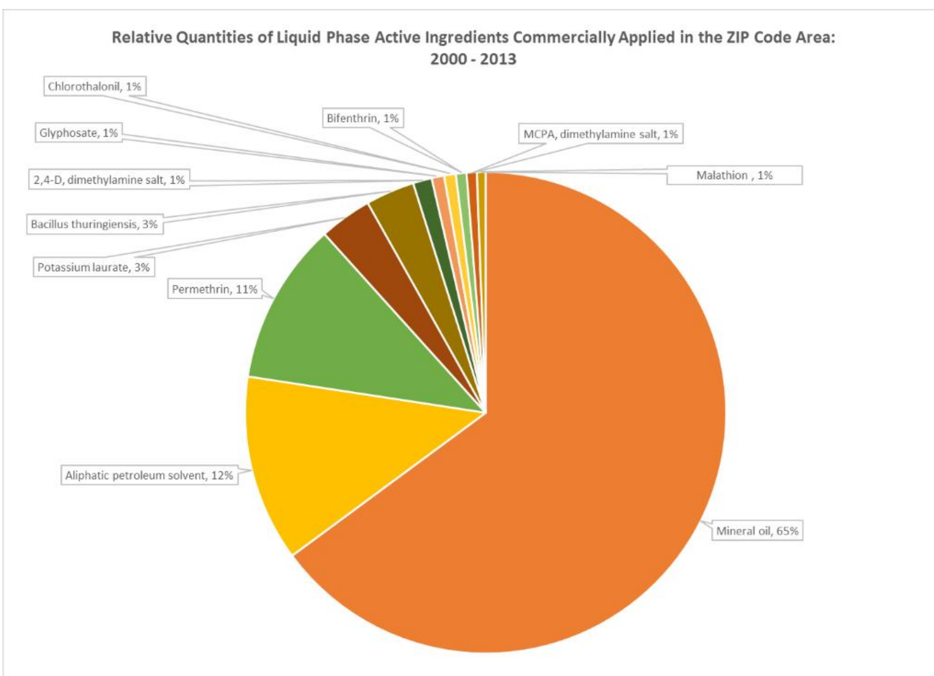


Figure 6. Percentages of liquid phase active ingredients commercially applied in the comparison area, 2000 – 2013.

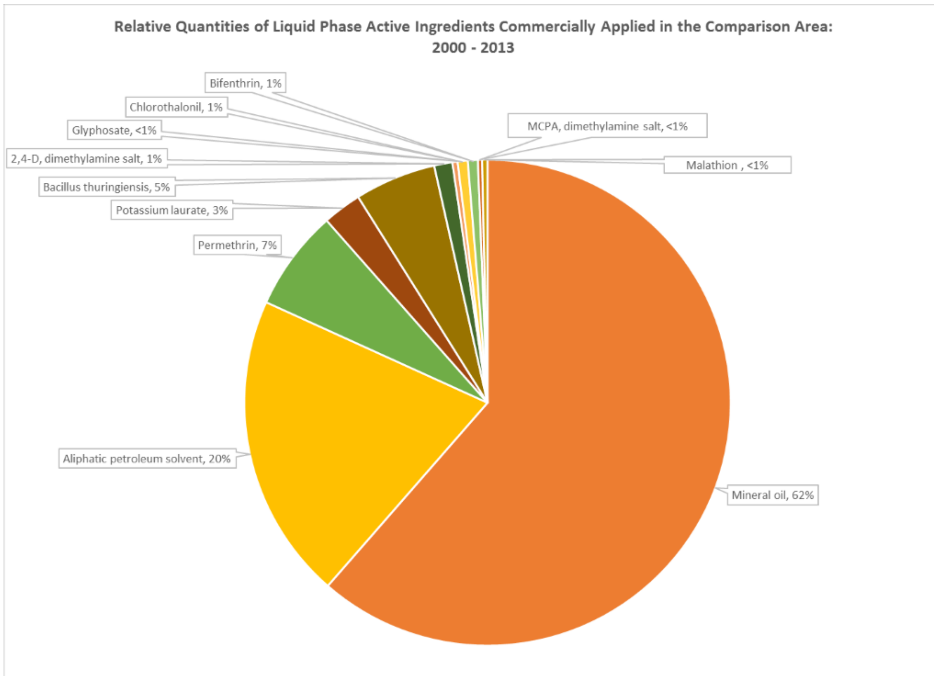


Figure 7. Percentages of solid phase active ingredients commercially applied in the ZIP code area, 2000 – 2013.

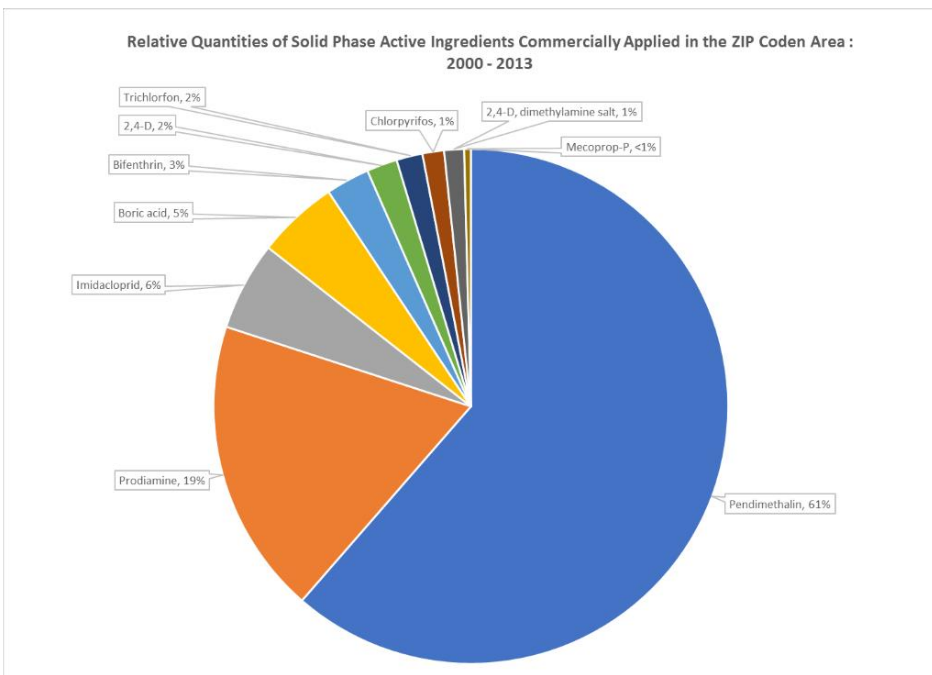
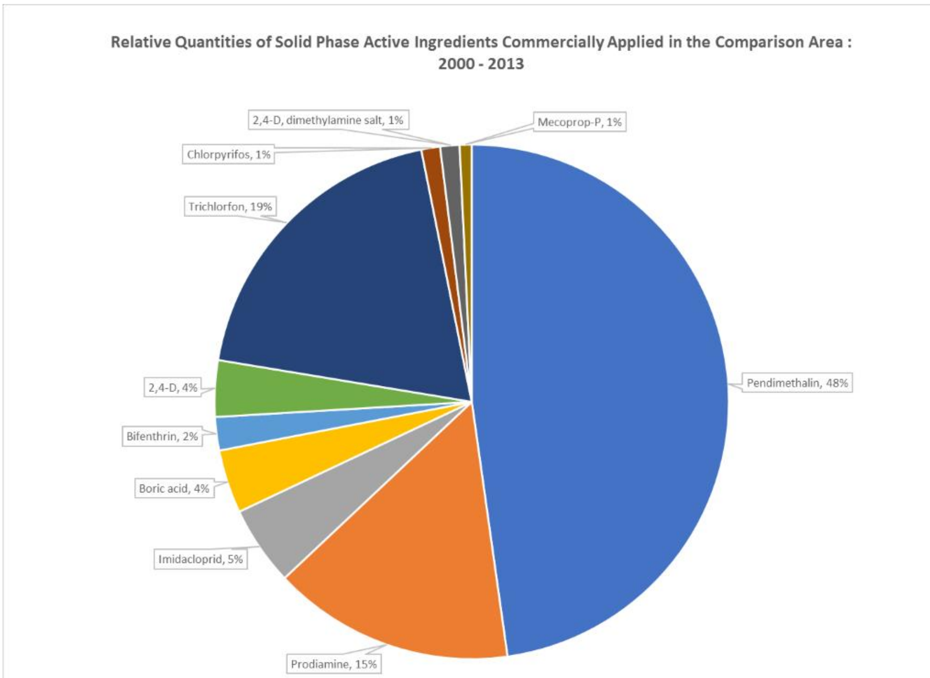


Figure 8. Percentages of solid phase active ingredients commercially applied in the comparison area, 2000 – 2013.



Most Widely Used Active Ingredients Commercially Applied in Solid Form

Pendimethalin is an herbicide used in preemergence (before weeds are present) and postemergence (when weeds are present) applications to control undesirable grasses, such as crabgrass, and certain broadleaf weeds. Most of the pendimethalin commercially applied in the areas examined was contained in products that also contain fertilizer, often referred to as weed and feed, that are marketed for turfgrass applications. In carcinogenicity studies using laboratory animals there was a statistically significant increased trend and pair-wise comparison between the high dose group and controls for thyroid follicular cell adenomas in male and female rats. However, pendimethalin was not mutagenic. The US EPA classified pendimethalin as a "possible human carcinogen" based on these findings.

Prodiamine is an herbicide used in preemergence applications to control undesirable grasses, such as crabgrass, and certain broadleaf weeds. Prodiamine is the active ingredient in a commonly used herbicide product called Barricade. Most of the prodiamine commercially applied in the areas examined was contained in products that are marketed for turfgrass applications. A number of these are weed and feed products that also contain fertilizer. In carcinogenicity studies using laboratory animals there was an increase in thyroid follicular cell neoplasia as well as a positive dose-trend in thyroid follicular cell adenomas and combined adenomas/carcinomas in male and female rats. Subcutaneous fibrosarcomas were also reported in male mice at the highest dose tested. The US EPA classified prodiamine as a "possible human carcinogen" based on these findings.

Imidacloprid is an insecticide that is used to control sucking insects that damage plants, chewing insects including termites, soil insects, and fleas on pets. Imidacloprid is the active ingredient in a commonly used insecticide product called Mallet. Most of the imidacloprid commercially applied in the areas examined was contained in products that also contain fertilizer, often referred to as weed and feed, that are marketed for turfgrass applications. Imidacloprid is added to these products to control grubs and other turfgrass insects. Imidacloprid did not product carcinogenic effects in laboratory animal studies resulting in a US EPA cancer classification of "evidence of non-carcinogenicity for humans." Imidacloprid did cause neurotoxicity in laboratory studies with dogs and rats.

Boric Acid is an insecticide that is obtained from mineral deposits in the earth. All of the boric acid commercially applied in the areas examined was in the form of natural fiber insulation treated with boric acid that can be blown in to attics and wall spaces. Boric acid did not cause cancer in studies with laboratory animals resulting in a US EPA cancer classification of "not likely to be carcinogenic to humans."

Bifenthrin is an insecticide that is used to control outdoor mosquitoes, fleas, termites, fire ants and ticks. Bifenthrin is a synthetic version of the naturally occurring pyrethroids that are found in chrysanthemums. Bifenthrin can only be applied by certified applicators or persons under their direct supervision. Most of the bifenthrin commercially applied in the areas examined was contained in products that also contain fertilizer, often referred to as weed and feed, that are marketed for turfgrass applications. The US EPA has classified bifenthrin as a "possible human carcinogen" primarily based on an increase incidence of urinary bladder tumors in high-dose male mice in carcinogenicity studies.

2,4-D is an herbicide used to control broadleaf weeds without damaging surrounding turfgrass. 2,4-D is usually combined with two additional active ingredients, mecoprop and dicamba, and fertilizer in weed and feed products marketed for turfgrass application. These turfgrass products often have the word trimec or triplex in their name. Of the three active ingredients, 2,4-D is present in the greatest quantities. All of the 2,4-D commercially applied in the areas examined was contained in weed and feed turfgrass products. The US EPA has determined that 2,4-D is "not classifiable as to human carcinogenicity" based on studies in rats and mice that showed no statistically significant tumor response in either species. In toxicity studies using rats, 2,4-D was associated with neurotoxic effects in an acute study (slight gait abnormalities and increased incidence of incoordination), fetal skeletal abnormalities in a developmental study, and kidney toxicity.

Trichlorfon is an insecticide used to control cockroaches, crickets, silverfish, bedbugs, fleas, cattle grubs, flies, ticks, leafminers and leaf-hoppers. Trichlorfon is the active ingredient in a commonly used insecticide product called Dylox. All of the Trichlorfon commercially applied in the areas examined was contained in granular products marketed to control grubs and other insects in turfgrass. The US EPA has classified trichlorfon as "not likely to be carcinogenic to humans at low doses, but is likely to be carcinogenic at high doses" based on carcinogenicity studies in rats, mice, and monkeys. Trichlorfon was found to cause neurotoxicity through brain cholinesterase inhibition in toxicity studies with rats and monkeys.

Chlorpyrifos is an insecticide that was used to control a wide variety of insects including termites and mosquitoes. Chlorpyrifos was the active ingredient in the insecticide products Lorsban and Dursban. In 2001, a ban on residential use was placed on chlorpyrifos. Since the ban went into effect chlorpyrifos can only be applied by professionals and its use is restricted to controlling termites. All of the chlorpyrifos commercially applied in the areas examined was contained in products that were marketed for controlling grubs and other insects in turfgrass. There were no applications of products containing chlorpyrifos reported in the areas examined after 2002. The US EPA has classified chlorpyrifos as "not classifiable as to human carcinogenicity" based on no evidence of carcinogenicity in studies using rats and mice. Chlorpyrifos has been associated with nervous system effects in studies with rats, mice and dogs. These nervous system effects have also been seen in people exposed to chlorpyrifos.

2,4-D dimethylamine salt is a form of the herbicide 2,4-D.

Mecoprop-p is an herbicide used in postemergence applications to control broadleaf weeds. Mecoprop-p is usually combined with two additional active ingredients, 2,4-D and dicamba, and fertilizer in weed and feed products marketed for turfgrass application. These turfgrass products often have the word trimec or triplex in their name. All of the mecoprop-p commercially applied in the areas examined was contained in weed and feed turfgrass products. The US EPA has classified mecoprop-p as having "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential." This conclusion was based on increased occurrence of liver cancers in female mice with no evidence of carcinogenic effects in male mice. Additionally, the carcinogenicity study using rats was deemed inadequate for purposes of the cancer review. Mecoprop-p was also associated with developmental toxicity (skeletal abnormalities) and neurotoxicity in rats as well as damage to the kidneys in mice.

Most Widely Used Active Ingredients Commercially Applied in Liquid Form

Mineral oil is an insecticide used to control insects, such as mites and aphids. Mineral oil used as an insecticide is also commonly referred to as Horticultural oil. Horticultural oils work primarily by suffocating insects and their eggs.

Aliphatic petroleum solvent is an insecticide used to control insects, such as mites and aphids. Aliphatic petroleum solvent is also commonly referred to as Horticultural oil. Horticultural oils work primarily by suffocating insects and their eggs.

Permethrin is an insecticide used to kill a variety of insects including termites. Permethrin is a synthetic version of the naturally occurring pyrethroids that are found in chrysanthemums. Permethrin is the active ingredient contained in the pesticide products Dragnet and Astro. The US EPA has classified permethrin as "likely to be carcinogenic to humans" based on lung tumors in female mice and liver tumors in male and female mice.

Potassium laurate is used to control a variety of insects and mosses, algae, lichens, liverworts and other weeds. Potassium laurate is also referred to as a soap salt. Most of the potassium laurate applied in the areas examined was in products marketed to control mites and fungus.

Bacillus thuringiensis is a microbe naturally found in soil that makes proteins that are toxic when eaten by immature insects (larvae). Target insects include beetles, mosquitoes, black flies, caterpillars, and moths. The specific strain applied in the area examined, Bacillus thuringiensis Subsp. Kurstaki, Strain ABTS-351, was contained in products marketed to control the larvae of moths and butterflies, such as tent caterpillars.

2,4-D dimethylamine salt is an herbicide used to control broadleaf weeds without damaging surrounding turfgrass. 2,4-D is typically combined with two additional active ingredients, mecoprop and dicamba in products marketed for applications on turfgrass. The US EPA has determined that 2,4-D is "not classifiable as to human carcinogenicity" based on studies in rats and mice that showed no statistically significant tumor response in either species. In toxicity studies using rats, 2,4-D was associated with neurotoxic effects in an acute study (slight gait abnormalities and increased incidence of incoordination), fetal skeletal abnormalities in a developmental study, and kidney toxicity.

Glyphosate is an herbicide used to control undesirable grasses, such as crabgrass, and broadleaf weeds. Glyphosate is the active ingredient in the pesticide products Roundup and Razor. These products are marketed for applications on turfgrass. The US EPA recently reviewed the available scientific studies that looked at glyphosate's potential to cause cancer. These studies looked at laboratory animals exposed to glyphosate for their lifetimes as well as groups of people who used or worked around glyphosate for a long period of time (e.g., farmers, pesticide applicators). The US EPA concluded that based on the available scientific information, glyphosate is "not likely to be carcinogenic to humans." Glyphosate was associated with effects on the eyes, liver, and/or kidney in studies using high doses with laboratory animals. Additionally, no associations were found when studies looked at long-term occupational exposure to glyphosate (e.g., farmers, pesticide applicators) and health effects.

Chlorothalonil is a fungicide used to control fungus on turfgrass, vegetable gardens, ornamental trees, and crops. Chlorothalonil is the active ingredient found in the pesticide products Bravo, Echo, and Daconil. The US EPA classified chlorothalonil as "likely to be a human carcinogen by all routes of exposure." This determination was based on increased incidence of renal adenomas and carcinomas in both sexes of rats and mice and increased incidence of papillomas and/or carcinomas of the forestomach in rats and mice.

Bifenthrin is an insecticide that is used to control outdoor mosquitoes, fleas, termites, fire ants and ticks. Bifenthrin is a synthetic version of the naturally occurring pyrethroids that are found in chrysanthemums. Bifenthrin can only be applied by certified applicators or persons under their direct supervision. Bifenthrin is the active ingredient contained in the pesticide product Talstar. The US EPA has classified bifenthrin as a "possible human carcinogen" primarily based on an increase incidence of urinary bladder tumors in high-dose male mice in carcinogenicity studies.

MCPA, dimethylamine salt is an herbicide used in postemergence applications to control broadleaf weeds such as chickweeds, dandelions and clover. MCPA is the active ingredient in the pesticide product Horsepower which is marketed for applications on turfgrass. The US EPA has classified MCPA as "not likely to be carcinogenic to humans." MCPA was associated with developmental toxicity (litter resorptions), neurotoxicity, as well as liver and kidney effects in studies using rats.

Malathion is an insecticide used to control a broad range of insects in both indoor and outdoor environments. Malathion is the active ingredient in the pesticide product Prentox. The US EPA has classified malathion as having "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential." This classification was based on liver tumors in male and female mice and in female rats, however these tumors were only seen in doses that were deemed excessive. Additionally, malathion was not mutagenic in genotoxicity studies.

Additional limitations for the evaluation of pesticide use data

Socioeconomic considerations, such as annual income, home value, educational level, etc., that may influence where pesticides are professionally applied were not taken into consideration. Some pesticide database records could not be used in this evaluation because of missing, invalid, or illegible entries for the ZIP code and/or EPA Registration number. Records that reported pounds applied for liquid products or gallons applied for solid products were also excluded. Unusable data may impact a spatial evaluation such as this if applicators that provide service to some areas are more prone to making reporting errors than applicators providing service to other areas. An assumption was made that evaluating only the pesticide products that accounted for the top 90% of the gallons and pounds applied also captures the bulk of the active ingredients applied. The validity of this assumption was not tested.

Appendix 4: Specific Issues Brought Up by Stakeholders and the Public

1. All Cancer Types, Including Rarer Cancers and Cancers in Children

Table 1. Observed and expected numbers of incident cancer cases, Centereach/Farmingville/Selden study area, Suffolk County, New York 2011-2015

SITES	Males and Females Combined except where noted			
	Observed	Expected[1]	Observed/Expected	95% CI
All Sites	**1976**	**1734**	***1.14**	**(1.09,1.19)**
Oral Cavity / Pharynx	**59**	**41**	***1.44**	**(1.10,1.86)**
Esophagus	24	18	1.36	(0.87,2.03)
Stomach	32	24	1.33	(0.90,1.87)
Colorectal	127	130	0.98	(0.82,1.16)
Liver / Intrahepatic Bile Duct	26	25	1.02	(0.67,1.50)
Pancreas	**65**	**46**	***1.40**	**(1.08,1.79)**
Larynx	14	12	1.12	(0.61,1.88)
Lung / Bronchus	**311**	**222**	***1.40**	**(1.25,1.57)**
Females Only				
Female Breast	261	259	1.01	(0.89,1.14)
Cervix uteri	**22**	**12**	***1.87**	**(1.17,2.82)**
Corpus Uterus / Uterus NOS	62	63	0.98	(0.75,1.26)
Ovary	27	24	1.15	(0.76,1.67)
Males Only				
Prostate	203	217	0.93	(0.81,1.07)
Testis	--[a]	11	--[a]	--[a]
Urinary Bladder (including in situ)	**112**	**86**	***1.30**	**(1.07,1.56)**
Kidney / Renal Pelvis	**86**	**63**	***1.37**	**(1.10,1.70)**
Brain / Other Nervous System	31	24	1.30	(0.88,1.84)
Thyroid	**98**	**67**	***1.46**	**(1.18,1.77)**
Hodgkin Lymphoma	9	11	0.83	(0.38,1.58)
Non-Hodgkin Lymphoma	75	74	1.01	(0.79,1.27)
Multiple Myeloma	33	25	1.32	(0.91,1.85)
Leukemias	**87**	**58**	***1.51**	**(1.21,1.86)**
Melanoma	85	78	1.09	(0.87,1.35)
All Other Sites	122	144	0.85	(0.71,1.01)

[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group-level populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total five-year populations: 160,539 males and 162,538 females.
[a]The number of cases is not shown to protect patient confidentiality.
*Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

People at the meeting expressed concerns over other types of cancer than the ones of primary focus in this study, including some rare cancer types and cancers in children. Table 1 summarizes incidence of the most frequently diagnosed types of cancer in the CFS study area for persons of all ages compared to New York State excluding New York City.

- For males and females combined,
  - The total number of cancers observed was statistically significantly more than the number of cases of cancer expected. Much of this excess was due to higher numbers of the cancers focused on in this investigation, lung, bladder, thyroid and leukemia.
  - Statistically significant excesses were also found in the number of cancers of the oral cavity/pharynx, pancreas, and kidney.
- In males,
  - The most common types of cancer observed included prostate, lung, and urinary bladder.
  - Fewer than six cases of cancer were observed for cancer of the testis.
  - None of the cancer sites for males only had a statistically significant excess.
- In females,
  - The most common types of cancer observed included breast, lung, and thyroid. Community members had expressed particular concern over cases of breast cancer in the area. The number of cases of breast cancer diagnosed among women in the CFS study area between 2011 and 2015 was not significantly different from the number expected.
  - For the females only sites, a statistically significant excess was found in the number of cancers of the cervix.

Community members also expressed concerns over rarer cancers occurring in the CFS study area. The grouping "All other sites" was therefore examined more closely. The 122 tumors in males and females involved a variety of locations in the body. The most frequently diagnosed cancer types were various cancers of the blood-forming system such as polycythemia vera, essential thrombocythemia, and myelodysplastic syndrome, with 33 cases; cancers of the small intestine, gallbladder and other parts of the digestive system, with 25 cases; and tumors where the organ where the cancer started could not be identified (unknown primaries), with 22 cases. Other cancers in this category involved the nose and nasal cavity; the bones and joints; soft tissues such as blood vessels and fibrous tissues; female reproductive organs other than the uterus and cervix; the ureter and other urinary organs other than the bladder and kidney; the eye; endocrine organs other than the thyroid; the lining of the lung and abdominal cavity (mesothelioma); and the bone marrow. When compared with the incidence of these conditions in the comparison population, the numbers of people with these diagnoses did not appear unusual.

A community member had reported that a family member had been diagnosed with dermatofibrosarcoma of the skin. There were no cases of this type of cancer identified in study area residents between 2011 and 2015. It is possible that the family member had been diagnosed before or after these years or had relocated from the study area prior to diagnosis.

Cancers in children were also mentioned as being of concern. All cancer analyses conducted in this study include people of all ages, including children, and children under the age of 20 were examined as a separate subgroup in the analyses of the four cancers of focus. Because of the community concerns, we also examined the incidence of all types of cancer in children separately. To do this, we identified all cases of cancer diagnosed in children under the age of 20 in the study area and compared the total number of cases and the numbers of cases in 12 groups (as specified by the International Classification of Childhood Cancers, ICCC) with the numbers expected for the CFS study area based on rates for New York State excluding New York City. Findings are shown in Table 2 below.

Table 2. Observed and expected number of childhood cancer cases, ages 0-19, males and females combined, Centereach/Farmingville/Selden study area, Suffolk County, 2011-2015

Site	Males and Females			
	Observed	Expected[1]	Observed/expected	95% confidence interval[2]
Leukemias	**12**	**4.1**	***2.96**	**(1.53,5.16)**
All Other Sites[a]	9	13.7	0.66	(0.30,1.25)
Total	21	17.7	1.18	(0.73,1.81)

[a]Includes Hodgkin lymphomas, non-Hodgkin lymphomas, central nervous system tumors, neuroblastoma, retinoblastoma, renal tumors, hepatic tumors, malignant bone tumors, soft tissue and other extraosseous sarcomas, germ cell tumors, other malignant epithelial neoplasms and malignant melanomas, and other and unspecified malignant neoplasms.
[1]Expected values are based on standard rates for New York State excluding New York City, for 2011-2015 and block-group populations from the 2010 US Census fitted to county-level populations for 2011-2015 provided by the National Cancer Institute's SEER Program. Total Five-Year Populations: 165,094 Males and Females
[2]Confidence intervals calculated by the method of Sahai and Khurshid (1993, 1996).
***** Significant difference between observed and expected at the $p < 0.05$ level (two-sided).

- The total number of cancers diagnosed in children was not significantly different from the number expected.
- As previously noted, the number of children who had been diagnosed with leukemia was significantly greater than the number expected, with about three times as many cases identified as expected. (Numbers of cases are not the same as in the main analysis due to differences between the ICCC and the system used to classify tumors in people of all ages).
- The numbers of cases of all other types of cancer, when combined and examined separately, were similar to the numbers expected. (To protect patient confidentiality, numbers of cases of specific types of cancer other than leukemia cannot be shown.)

2. Wood-Burning Stoves

A community member raised concerns over exposure to smoke from wood-burning stoves in his neighborhood. Scientists have determined that residential wood combustion in New York is an important source of fine particulates or soot in outdoor air. In rural counties, residential wood combustion is responsible for almost all (>90%) of carbonaceous PM2.5 emissions[1, 2]. The contribution is likely much less in more urbanized counties such as Suffolk.

Wood smoke is a complex mixture of particulates, aerosols, carbon monoxide, polycyclic aromatic hydrocarbons, benzene, aldehydes, nitrogen oxides and free radicals[3]. Emissions from wood-burning appliances can vary in the amount of wood smoke produced and its composition depending on the temperature of the wood fire, the technology employed in the appliance and the quality of the wood fuel. EPA states that the greatest health risk from wood smoke is associated with the fine particles, which can irritate the eyes and respiratory system, cause bronchitis and worsen or trigger asthma attacks and may also trigger heart attacks, stroke, irregular heart rhythms, and heart failure in at-risk populations. In 2010, the World Health Organization's International Agency for Research on Cancer (IARC) concluded that indoor emissions from household combustion of biomass fuel (mainly wood) are probably carcinogenic, although this conclusion was primarily based on exposures to smoke from fires used for indoor cooking and heating, which are not common in the US[4, 5].

The hazardous air pollutants from residential wood combustion (not including soot or particulate matter) are included as a non-point source in the NATA model. These estimates indicate that residential wood smoke contributes approximately one eighteenth of the total estimated cancer risk associated with hazardous air pollutants in the CFS study area, much less than in some rural areas of the state. Although the NATA model uses best available information for this source category, given the variability in emissions from individual wood-burning appliances and fireplaces, for example, there are significant uncertainties associated with estimating exposures to residential wood smoke on the neighborhood level.

Residents can reduce their wood smoke exposures and potential health risks by burning clean, dry, seasoned firewood in modern, efficient wood-burning appliances with stacks that extend beyond the roofline. The New York State Energy Research and Development Authority (NYSERDA) currently operates an incentive program to replace older, more polluting wood burning devices with cleaner, efficient appliances (see Renewable Heat NY: https://www.nyserda.ny.gov/All-Programs/Programs/Renewable-Heat-NY).

References

1. NYSERDA (New York State Energy Research and Development Authority). 2008. Assessment of Carbonaceous PM2.5 for New York and the Region. Albany, NY: Final Report 08-01.
2. NYSERDA (New York State Energy Research and Development Authority). 2010. Spatial Modeling and Monitoring of Residential Woodsmoke Across a Non-Urban Upstate New York Region. Albany, NY: Final Report 10-02.
3. Naeher *et al.*, 2007. "Woodsmoke Health Effects: A Review." *Inhalation Toxicology.* Volume 19, pp. 67–106, August 2007.
4. IARC (International Agency for Research on Cancer), 2010. IARC monographs on the evaluation of carcinogenic risks to humans. Volume 95. Household use of solid fuels and high temperature frying. Lyon: International Agency for Research on Cancer. Available at: https://monographs.iarc.fr/wp-content/uploads/2018/06/mono95.pdf.
5. Straif, K., *et al.* 2006. Carcinogenicity of household solid fuel combustion and of high-temperature frying. *The Lancet*. Volume 7, pp. 977-978, December 2006.

3. Nicolls Road

Nicolls Road, which runs in a generally north/south direction through almost the center of the study area, was mentioned by a member of the public as a possible source of the cancer elevations. If there were any exposures specific to Nicolls Road that were influencing cancer occurrence in the community, it would be expected that the levels of these exposures would tend to be greater, and therefore the excess risk of cancer related to these exposures would tend to be higher, for people living closer to Nicolls Road.

To examine any spatial patterns within the study area, tabulations of observed and expected numbers of cases by block group were examined. (These data were obtained from the Environmental Facilities and Cancer Mapping project, which may be found at https://health.data.ny.gov/.) A map of the block groups in the study area was then shaded according to whether incidence was greater than, about the same as, or less than expected (relative to a New York State standard). Due to relatively small numbers of cases in many of the block groups for some of the cancers, the block groups were also combined into their respective census tracts, and the census tracts shaded accordingly. To assess the possible contribution of exposures related to Nicolls Road on the incidence of the four cancers, the locations of the shaded block groups and census tracts relative to Nicolls Road were visually inspected.

There was a high degree of variability from one block group to another in relative numbers of observed and expected cases for all four cancers. Most of the block groups had numbers of cases that were greater than or about the same as (within 15% of) the numbers expected, which is to be expected given that this area had been identified as part of larger areas where the incidence of these cancers was greater than expected.

For lung cancer, which makes up over half of the cancers under study in the CFS study area, Nicolls Road runs through or forms the boundary of block groups where the numbers of observed cases are much greater than (over 100%), somewhat greater than (50-100%), greater than (15-49%), about the same as, and even less than expected. The block groups with the greatest elevations in lung cancer incidence were miles east of Nicolls Road. There was no consistent elevation in lung cancer rates in the block groups including or closest to Nicolls Road.

For bladder cancer, all the block groups containing or adjoining Nicolls Road had numbers of cases that were either greater than or about the same as the numbers expected. Many of the block groups in the study area that had the greatest elevations of bladder cancer cases contained or were near Nicolls Road, particularly the northern and central portions. When the addresses of persons in these block groups with bladder cancer were plotted individually, most of the addresses south of Middle Country Road were relatively distant from Nicolls Road. North of Middle Country Road, many of the addresses were within about ½ mile of Nicolls Road, mostly to the west and south, however none of the addresses were adjacent to Nicolls Road. This does not provide clear evidence of any effect related to proximity to Nicolls Road.

When the incidence of thyroid cancer was looked at by block group, there were no clear spatial patterns. The incidence was geographically very variable, which is not surprising due to the relatively small numbers of cases. Nicolls Road ran through or next to block groups ranging from having no cases of thyroid cancer to having numbers that were three times expected. Block groups with the highest and lowest numbers appeared to be randomly spread out over the area.

The incidence of leukemia was again quite variable from block group to block group, due to relatively small numbers of cases. All of the block groups containing or adjacent to Nicolls Road had numbers of leukemia cases either greater than or about the same as the numbers expected, and many of the block groups in the study area with the greatest elevations of leukemia cases were in the area of Nicolls Road. When the addresses of persons in these block groups with leukemia were plotted individually, there was no clear tendency for people with leukemia to live closer to Nicolls Road. Rather, the people with leukemia lived at varying distances from Nicolls Road, from adjacent to it to about a mile away. For one block group, much of the excess was due to the presence of two people who had each been diagnosed with two different types of leukemia at the same time. Following currently used cancer counting rules, the Cancer Registry counted both leukemias in both people. These findings do not provide any evidence that people diagnosed with leukemia tended to live closer to Nicolls Road.

4. Industrial and Inactive Hazardous Waste Disposal Sites Near the Study Area

Although there are no industrial or inactive hazardous waste disposal sites located within the boundaries of the CFS study area, community members raised concerns about several sites located just outside the area. The **Brookhaven Landfill**, which opened in 1974, is located in the Town of Brookhaven, about 4 ½ miles southeast of the CFS study area. The town of Brookhaven Waste Management Facility Site consists of approximately 534 acres between Horseblock Road and Sunrise Highway. Portions of the landfill are permanently closed while another section is near capacity and is undergoing closure. Types of waste disposed of at the landfill include municipal waste, incinerator ash and construction and demolition debris. There is no evidence that hazardous waste was disposed of at the landfill. The landfill has a gas collection system for methane that is burned to produce electricity. The landfill also has a permanent flare used to burn additional landfill gases. In response to the finding of a leachate plume in 1981-1983 and due to concerns about impacts to private wells, public water service was made available beginning in 1983 to those residents downgradient of the landfill. Nearby residents have raised concerns about odors and emissions which are being investigated by DEC (see factsheet http://www.dec.ny.gov/docs/air_pdf/casbhavenfact.pdf). Public health concerns regarding the landfill were the focus of a 2005 Public Health Consultation prepared jointly by the DOH and the Federal Agency for Toxic Substances and Disease Registry. This health consultation concluded that there was no apparent health hazard associated with the landfill (see https://www.atsdr.cdc.gov/HAC/pha/BrookhavenLandfil112905l/BrookhavenLandfillHC112905.pdf).

Prima Asphalt, Inc. and **Pure Recycled Products, Inc.** are located on an 18-acre property in an industrial-zoned area in the Town of Brookhaven adjacent to the CFS study area. Activities on the industrial site include manufacturing of hot-mix asphalt and recycling of uncontaminated concrete, asphalt, rock, brick and soil. This facility has operated an asphalt plant since the 1940s. The recycled materials operation started in 1996. DEC oversees regulatory activities for the facilities on site. The asphalt operations can generate odors and the recycling operation can generate dust. DEC has taken numerous steps to improve control of air pollution at Prima Asphalt and to control dust at Pure Recycled Products.

In 1998, Prima Asphalt began receiving and stockpiling crushed granite from the construction of a water tunnel in New York City. Residents complained of run-off and dust impacting their properties. Residents also expressed concern about crystalline silica or asbestos emanating from the site. DEC required the company to implement a dust control program and DOH, the Suffolk County Department of Health Services and the federal Agency for Toxic Substances and Disease Registry (ATSDR) investigated to determine if residents were exposed to crystalline silica and/or asbestos at levels of public health concern. This study did not detect any respirable crystalline silica, and asbestos was detected in a single sample collected near the facility and in two samples collected at the "background/reference" location. All three results were below the federal standard that for schools following asbestos abatement activities. A report on this investigation can be found on ATSDR's website at https://www.atsdr.cdc.gov/HAC/pha/PrimaAsphaltConcreteInc121305/PrimaAsphaltConcreteIncHC121305.pdf. Additional information on this facility is available from DEC.

In 1997, DOH, through a cooperative agreement with ATSDR, completed a health consultation for the **Holtsville, Farmingville, Holbrook and Lake Ronkonkoma** residential communities. Community members had expressed concerns about odors and air pollution from nearby industrial facilities. The 1997 health consultation categorized the issue as an "indeterminate health hazard" due to insufficient data. An air monitoring plan was enacted and air monitoring stations at four local school buildings and a residential neighborhood collected data for a variety of air pollutants from 1997 to 2003. These data were evaluated and summarized in a December 13, 2005 health consultation. Based on the available air monitoring data collected through 2003, the Holtsville site was categorized as posing no apparent public health hazard. The full report, including air monitoring data, report conclusions and limitations, is available on ATSDR's website (See "Holtsville Residential Area" available at https://www.atsdr.cdc.gov/HAC/PHA/HCPHA.asp?State=NY).

5. Northville Terminal Spill

At the community meeting in July 2018, residents voiced concerns about a gasoline spill at the Northville Terminal. In 1987, DEC was notified about a large gasoline spill at the Northville Terminal in East Setauket, about 1.5 miles north of the CFS study area. It was estimated that 1.2 million gallons of gasoline had leaked into the ground over ten years[1]. The leaked gasoline moved downward beneath the terminal until it reached the groundwater, about 100 feet below the surface. The extent of the groundwater contamination has been well characterized, and all residents previously served by private drinking water wells were connected to the public water system. Monitoring has shown that as of 2006, none of the well fields operated by the Suffolk County Water Authority had been impacted by the contamination. Two homes adjacent to the site were found to have been slightly affected by petroleum-related compounds in soil vapor, and these were remediated. In November of 2006, DEC reported that all remedial activities had been completed and any impacted off-site areas had been addressed (DEC).

Reference
1. DEC (New York State Department of Environmental Conservation). 2006. Fact Sheet: Northville Industries Terminal Road. Albany NY: November 2006.

6. SUNY Stony Brook Javits Lecture Center Fire

At the July public meeting, a resident expressed concern over a 1986 fire at a lecture center on the SUNY Stony Brook campus. The fire led to the contamination of the lecture center with hazardous chemicals, including dioxin. This contamination reportedly was not cleaned up for a year after the fire, potentially leading to student and staff exposures. According to a report published in the scientific literature[1], the fire occurred in late September 1986. It started in a concrete room that was being used to store custodial supplies. The fire caused smoke and fire damage to the storage room, adjoining service corridors, and two lecture halls. Among the materials consumed by the fire were various plastics and sources of chlorine; PCBs (polychlorinated biphenyls) were not among the materials found to have burned.

Extensive environmental testing was not conducted until months after the fire, after students had been using the lecture halls. As a result of this testing, polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were detected in amounts greater than background in several locations, all of which were inaccessible to students. Only the soot from the ventilation system in the storage room where the fire began contained PCDDs and PCDFs at levels above cleanup guidelines proposed at the time. Since any testing done immediately after the fire did not include PCDDs and PCDFs, it was not possible to evaluate the extent of exposure. The authors concluded that significant human exposures were unlikely[1].

Even if there had been significant exposures, a number of factors need to be considered when trying to relate these exposures to the excesses in the four cancers observed in the CFS study area. Appreciable numbers of students and staff who had been exposed in 1986-1987 would have to be living in the CFS study area during 2011-2015. Risks of any of the individual cancers occurring in a given year are low, and even a substantial elevation of risk with exposure would not account for many excess cases. While evidence suggests that PCDDs cause cancer in humans[2], most of the specific cancers for which there is some evidence of association with PCDD exposure (soft-tissue sarcomas and non-Hodgkin lymphoma) were not elevated in the CFS study area. The notable exception is lung cancer, which is elevated in the CFS study area and is included in the category of respiratory cancers, which have been associated with PCDD exposures in some studies. There are many other, more common, known causes of lung cancer, however. It is thus not likely that the fire in the lecture center could have contributed to the excess in cancers in the CFS study area.

References
1. Deutsch DG and Goldfarb TD, PCDD/PCDF contamination following a plastics fire in a university lecture hall building, *Chemosphere 17*(12): 2423-2431, 1988.
2. ATSDR (Agency for Toxic Substances and Disease Registry) (1998) Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. US Department of Health and Human Services, December 1998. Available at https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=366&tid=63.

7. Chlordane for Termite Control

Community members expressed concerns about past use of the pesticide chlordane. Chlordane is a man-made substance that was formerly used as a pesticide on agricultural crops, lawns and gardens. Chlordane is not easily broken down and persists in the environment. In 1983, EPA restricted its use to the control of termites only, and it was banned completely in 1988[1]. Prior to being banned, chlordane was widely used for termite control on Long Island.

Chlordane is known to cause liver cancer in animals, however the evidence for carcinogenicity in humans is unclear. The US EPA has classified it as a probable human carcinogen, while the National Toxicology Program has not classified it as to its carcinogenicity and the International Agency for Research on Cancer has categorized it as possibly carcinogenic to humans. Among the types of cancer that have been inconsistently associated with chlordane are cancers of the breast and prostate, and non-Hodgkin lymphoma[1].

Mandated reporting of pesticide applications by commercial applicators did not begin in New York until 1997, after chlordane had been banned, so there are no readily available data on past chlordane application in the study area. For the years for which data are available, the use of pesticides by commercial applicators to keep lawns green and free of weeds and insects in ZIP Codes approximating the CFS study area appears to be less than in the comparison area in Suffolk County.

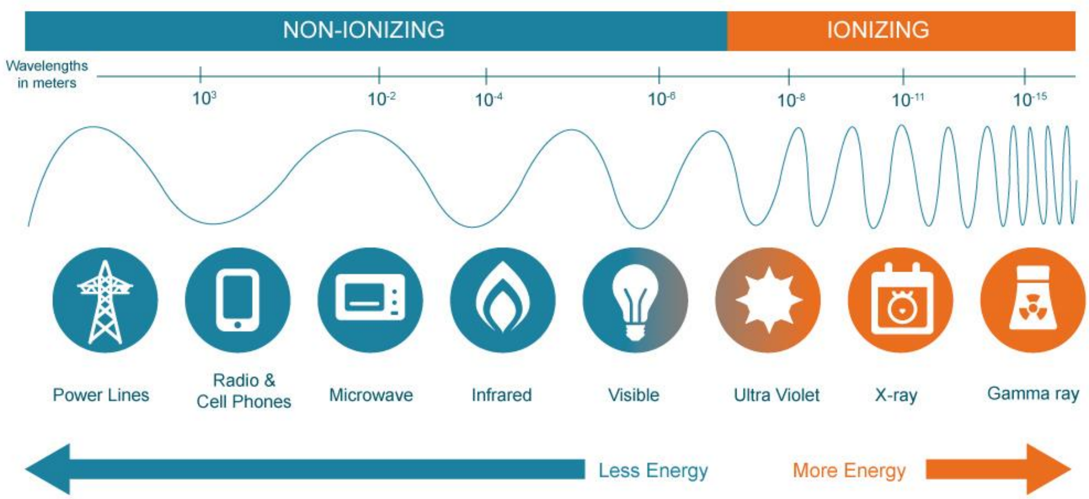
Reference
1. ATSDR (Agency for Toxic Substances and Disease Registry) (2018) Toxicological Profile for Chlordane. US Department of Health and Human Services, February 2018. Available at https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=355&tid=62.

8. Electromagnetic Radiation (Power Lines and Radio/Cell Phone Towers)

Community members have suggested that the excesses in various cancers in the CFS study area may be related to exposure to forms of electromagnetic radiation, including dental X-rays, radio and cellular telephone towers, and electric power lines.

The electromagnetic spectrum extends from low frequencies used for radio communication to high-frequency, high-energy gamma radiation, covering wavelengths from thousands of kilometers down to a fraction of the size of an atom. Radiation in the far ultraviolet, X-ray and gamma-ray ranges and all particle radiation from radioactive decay is considered ionizing radiation. Ionizing radiation has enough energy to cause atoms to become charged or ionized. The regions of the spectrum consisting of near ultraviolet, visible light, infrared, microwave, and radio waves are considered non-ionizing radiation. Non-ionizing radiation does not have enough energy to ionize an atom or molecule. A graphical representation of the electromagnetic spectrum is shown in Figure 1.

Figure 1. A graphical representation of the electromagnetic spectrum

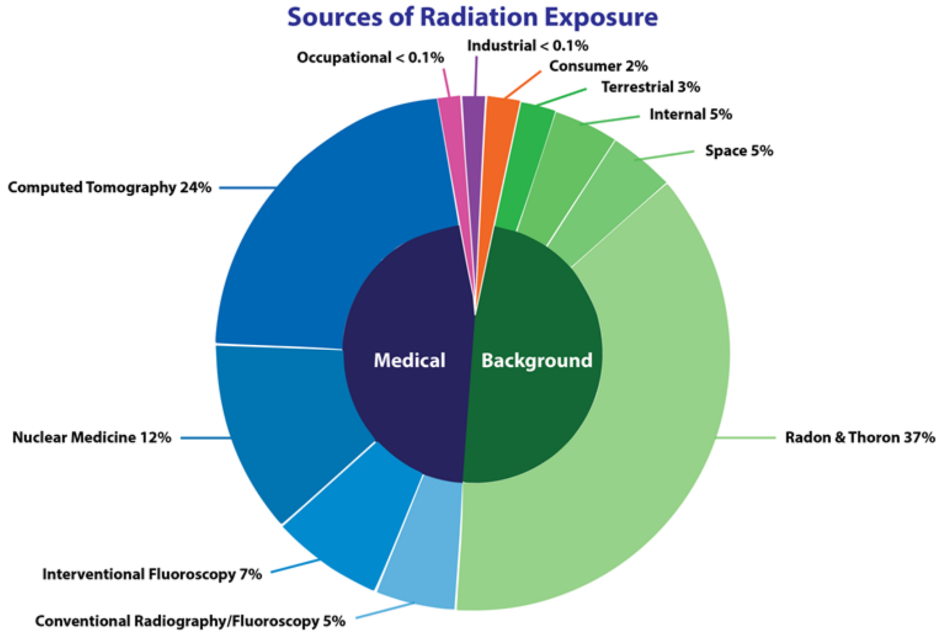


(From https://www.mirion.com/introduction-to-radiation-safety/what-is-radiation)

A concern was raised about the elevated number of cases of thyroid cancer being related to dental X-rays, which are a form of ionizing radiation. Human beings are exposed to natural background ionizing radiation every day from the ground, building materials, air, food, space, and even elements in their own bodies. In the United States, most of exposure to background radiation comes from exposure to radon gas and its decay products. The other major source of radiation exposure to the public is medical procedures (X-rays, CT scans, etc.) Figure 2 breaks down the sources of radiation by category.

The numbers reflected in the graph are averages; individual exposures will vary. Factors that might increase exposure to ionizing radiation include (1) increased use of radiation for medical purposes, (2) occupational exposure to radiation, and (3) smoking tobacco products. Factors that might decrease radiation exposure include living at lower altitudes (less cosmic radiation) and living and working on the higher floors of a building (less radon).

Figure 2. Source of radiation exposure and average annual radiation dose



Average Annual Radiation Dose

Sources	Radon & Thoron	Computed Tomography	Nuclear Medicine	Interventional Fluoroscopy	Space	Conventional Radiography/ Fluoroscopy	Internal	Terrestrial	Consumer	Occupational	Industrial
Units mrem (United States)	228 mrem	147 mrem	77 mrem	43 mrem	33 mrem	33 mrem	29 mrem	21 mrem	13 mrem	0.5 mrem	0.3 mrem
mSv (International)	2.28 mSv	1.47 mSv	0.77 mSv	0.43 mSv	0.33 mSv	0.33mSv	0.29 mSv	0.21 mSv	0.13 mSv	0.005 mSv	0.003 mSv

(Source: National Council on Radiation Protection & Measurements, Report No. 160)

The average annual radiation dose to the US population is approximately 620 millirem (6.2 millisievert). Of this, the largest contribution from medical procedures comes from CT scans (147 mrem/1.47 mSv) and nuclear medicine, which includes radiation therapy for cancer and other conditions (77 mrem/0.77 mSv). Conventional radiography, including such procedures as chest X-rays and dental X-rays, accounts for only 33 mrem (.33 mSv), or about 5% of the total. The most thoroughly studied individuals for the determination of the health effects of exposure to ionizing radiation are the survivors of the Hiroshima and Nagasaki atomic bombs. Increased cancer rates have been seen at radiation dose levels of about 10 to 400 rem (100 to 4000 millisievert), or about 40 to 1600 times the average yearly background exposure.

At a radiation dose of 10 rem (100 millisievert), approximately 1 person in 100 would be expected to develop cancer, while approximately 40 out of 100 people would be expected to develop cancer from other causes. Lower radiation doses would produce proportionally lower risks, i.e., approximately one individual in a thousand would develop cancer from an exposure to 10 millisievert.

Studies have linked thyroid cancer to exposure to ionizing radiation, particularly high-dose radiation used to treat various medical conditions and to childhood exposures to radioactive iodine. Recent studies of the relation of thyroid cancer to dental X-rays have been conflicting.

One prospective cohort study[1], in which information on radiation exposures was recorded before the diagnosis of cancer, found an association of thyroid cancer cases with dental X-rays but not with other diagnostic X-ray procedures that provide greater radiation doses to the thyroid. This association was found only in people who had first received dental X-rays prior to 1970, when doses were higher and neck shielding was not widely used. While the association between dental X-rays before 1970 and thyroid cancer may be causal, it may also reflect greater contact with the medical care system and opportunity to be diagnosed with thyroid cancer by people who have more dental X-rays.

If dental X-rays taken before 1970 do increase the risk of thyroid cancer, to prove that this source contributed to the excess in thyroid cancer cases in the CFS study area, one would need to show that people in the CFS study area who developed thyroid cancer between 2011 and 2015 were more likely than average to have had dental X-rays beginning in 1970. Much of the excess in thyroid cancer cases in the CFS study area was among persons under age 50, who would have been born in 1961 or later and thus would have had little or no opportunity to have received dental X-rays before 1970. For the remainder of people, records of dental X-rays given before 1970 would be difficult or impossible to obtain, and individual recollections would be subject to bias. There do not appear to be any reliable sources of data on exposure to dental X-rays before 1970 among study area residents between 2011 and 2015.

People also expressed concerns about radio and cell phone towers, and about electric power lines. Wireless devices such as cell phones, cordless phones, cellular antennas and towers, automatic meter readers (smart meters), and broadcast transmission towers produce radiation in the radiofrequency (RF) and microwave radiation (MR) ranges. Electrical and electronic appliances and power lines produce extremely low frequency electromagnetic fields (ELFs). These are all in the non-ionizing part of the spectrum, and do not have enough energy to remove electrons from atoms.

The use of cell phones and the internet has increased dramatically in recent years, and RF radiation is omnipresent in the environment. Research on health effects produced by exposure to RF radiation is still evolving. The scientific community is divided about whether RF radiation represents a health hazard. Recent studies by the National Toxicology Program (NTP) of the National Institute of Environmental Health Sciences found that long-term exposure to cell phone radiation causes carcinogenic effects in rats and mice[2, 3]. Wireless communication, however, is widely used throughout New York State, not only in Suffolk County. It is not likely that exposure to RF radiation such as that produced by cell phones is related to the higher incidence of certain cancer.

Extremely low frequency electromagnetic fields are produced by power lines, electric substations and common electric household devices. The human body is conducting, hence, when we stand in a 60 Hz field, currents will flow in our bodies. The size of the currents induced in the body depends on the strength of the field. At high field strengths, some biologic effects such as changes in heart rate, nerve stimulation and tissue heating are well known.

In 1979, Wertheimer and Leeper reported increased incidence of childhood leukemia in homes close to distribution lines, although later studies have had mixed results. Three studies that combined the results of other studies found increases in childhood leukemia only among children with exposures to very high magnetic field levels (0.3 or 0.4 micro Tesla or more), which were experienced by very few of the children. Most of the recent studies have not shown an association between exposures to ELF electromagnetic fields in adults[4].

In the CFS, visual inspection of the street-level base map included in the Environmental Facilities and Cancer Mapping application shows two sets of power transmission lines. One runs in a roughly north-south direction from the Port Jefferson Power Station through the study area, crossing Nicolls Road and running west of Nicolls Road to the Long Island Expressway and beyond. The other set of power transmission lines connects with the first at the Holbrook substation, running in an east-west direction north of the Long Island Expressway. When the locations of the addresses at diagnosis of the children diagnosed with leukemia were examined in relation to the power lines, a few (less than half) of the children were found to have lived within 1000 ft of the north-south lines.

New York State regulates the field strength of transmission lines at the edge of the right-of-way. The limit for magnetic field strength at the edge of the right-of-way in New York is 20 micro Tesla. Electric and magnetic fields from power lines drop off rapidly with distance from the lines. Closer examination showed that none of the children's residences bordered the power line right-of-way, and none was within 300 ft of any power line. It thus does not appear that any of the children with leukemia lived close enough to the power transmission lines to experience a magnetic field intensity approaching that which might be sufficient to increase the risk of leukemia.

References

1. Neta G, Rajaraman P, Berrington de Gonzalez A, et al., A prospective study of medical diagnostic radiography and risk of thyroid cancer, *Am J Epidemiol 177*(8):800-809, 2013.

2. National Toxicology Program (NTP), Toxicology and carcinogenesis studies in Hsd:Sprague Dawley rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones, NTP TR 595, Research Triangle Park NC: National Toxicology Program, November 2018a. Available at https://ntp.niehs.nih.gov/results/areas/cellphones/. Accessed April 5, 2019.

3. National Toxicology Program (NTP), Toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1,900 MHz) and modulations (GSM and CDMA) used by cell phones, NTP TR 596, Research Triangle Park NC: National Toxicology Program, November 2018b. Available at https://ntp.niehs.nih.gov/results/areas/cellphones/. Accessed April 5, 2019.

4. National Cancer Institute (NCI) 2019, Electromagnetic Fields and Cancer, available at https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet. Accessed April 10, 2019.