

Health Consultation

ANALYSIS OF CANCER INCIDENCE IN THE POMPTON LAKES
NEIGHBORHOOD IMPACTED BY THE DUPONT
GROUNDWATER CONTAMINATION

POMPTON LAKES, PASSAIC COUNTY, NEW JERSEY

EPA FACILITY ID: NJD980771604

**Prepared by the
New Jersey Department of Health and Senior Services**

December 7, 2009

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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Purpose

At the request of the mayor of Pompton Lakes, cancer incidence was evaluated for the neighborhood situated above the Dupont Pompton Lakes Works groundwater contamination plume. Total cancer incidence and 13 specific cancer types were evaluated in this investigation. The specific cancer types were selected because they represent cancer groupings that may be more sensitive to the effects of environmental exposure, though not necessarily related to potential groundwater contaminants.

Background and Statement of Issues

In the late 1800s, the facility began operations manufacturing blasting caps and smokeless powder. In 1902, Dupont took over operations at the facility. Waste management practices during this time have resulted in significant contamination of surface water, soil and sediment, and groundwater contamination both on and off site (ATSDR 1994). In the early 1980s, groundwater monitoring on site found elevated levels of metals (lead and mercury) and a number of chlorinated solvents (such as trichloroethylene (TCE) and tetrachloroethylene (PCE)). In the mid to late 1980s Dupont began testing private wells adjacent to the facility property and detected heavy metals and chlorinated solvents (ATSDR 1994). By 1989, all homes with private wells in the area adjacent to the facility were connected to the municipal water utility.

In 1998, DuPont installed a system along the southeast boundary line to pump contaminated groundwater and to treat it. After treatment, the water is discharged back to the ground. The groundwater is being monitored to assess the effectiveness of the system. The groundwater underlying the residential neighborhood, south of the Dupont facility, is impacted by chlorinated volatile organic solvents (Corporate Remediation Group 2008). The pump and treat system is preventing further contamination from leaving the Dupont site and treated water is being injected back into the aquifer at the edge of the off-site plume. Chlorinated VOCs volatilizing from shallow groundwater are a potential source of VOCs in soil gas and sub-slab soil gas overlying the groundwater plume. Buildings within the chlorinated VOC groundwater plume are primarily single-family homes which, based on observations to date, have basements with concrete floor slabs that are intact and lack significant cracks or other openings to the subsurface, creating a potential exposure pathway to residents in the affected area.

During the first half of 2008, DuPont conducted sub-slab soil gas sampling at select locations in off-site areas above the plume. These results indicated exceedances of the comparison levels for chlorinated VOCs. In accordance with the New Jersey Department of Environmental Protection vapor intrusion guidelines, a protective vapor mitigation system was offered to each of these residents (Corporate Remediation Group 2008). Additional testing of indoor air and/or sub-slab soil gas sampling was offered to 436 homes identified as being in the potential vapor migration area. At present 368 homes have been sampled and/or designed for installation of a mitigation system. Post-mitigation sampling is currently underway to test the efficacy of the mitigation system (NJDEP personal communication 2009).

Methods

Survey Area and Population

The Pompton Lakes survey area for the evaluation of cancer incidence consisted of the entire population residing in census blocks above the Dupont groundwater contamination plume in Pompton Lakes, Passaic County. Population counts for the area were determined from the 2000 U.S. Census data (Census 2001) using census block information. The entire census block containing any residential homes sitting above the groundwater plume were included in the survey area, with two exceptions. Populations from these two blocks were proportionally imputed using one of the partial census blocks. Since the groundwater plume does not exactly match census block boundaries, some residences in the survey area are not above the plume. A map of the survey area is presented in Figure 1.

Cancer Case Ascertainment and Survey Period

The New Jersey State Cancer Registry (NJSCR) was used to determine cancer cases. The NJSCR is a population-based cancer incidence registry covering the entire state of New Jersey. By law, all cases of newly diagnosed cancer are reportable to the NJSCR, except for certain carcinomas of the skin. In addition, the NJSCR has reporting agreements with the states of New York, Pennsylvania, Delaware, Maryland, North Carolina, and Florida. Information on New Jersey residents who are diagnosed in those states is supplied to the NJSCR. The NJSCR has been in operation since October 1, 1978 and maintains complete years of cancer data in New Jersey from 1979 to 2006.

The survey period for this investigation was January 1, 1979, through December 31, 2006. A "case" was defined as an individual who was diagnosed with a new primary malignant cancer during the survey period while residing in the survey area. NJSCR cases identified only through search of death or autopsy records were excluded from this evaluation.

All cancer cases from the New Jersey State Cancer Registry identified as Pompton Lakes residents were reviewed to determine geographic location of residence at the time of diagnosis within the Borough. Census block location was determined using NJSCR data fields, the U.S. Census Bureau website (AmericanFactFinder), Google Earth, and street maps.

Information on important cancer risk factors, such as genetics, personal behaviors (e.g., diet and smoking), or occupational history, is not available from the NJSCR.

Data Analysis

Analyses were completed for all malignant cancer types combined and for select cancer types for the census blocks in Pompton Lakes. The select cancer types analyzed include bladder, brain and central nervous system (CNS), female breast, colorectal, esophageal, pancreas, lung, leukemia, non-Hodgkin lymphoma (NHL), liver, bone, stomach, and kidney. These cancer types were evaluated because they represent cancer groupings that may be more sensitive to the effects of environmental exposures. Males and females were evaluated separately. In addition, since

only age-sex specific population data were available in the year 2000 for census blocks, separate analyses were conducted for the 13-year period centered around 2000, 1994-2006.

Standardized incidence ratios (SIR) were used for the quantitative analysis of cancer incidence in the study area (Kelsey et al. 1986; Breslow and Day 1987). The SIR is calculated by dividing the observed number of cases (from the NJSCR) by an expected number for the surveyed population over the two evaluation time periods, 1979 to 2006 and 1994 to 2006.

The expected number was derived by multiplying a comparison population's age-sex-specific cancer incidence rates and the study area age-sex-specific population figures. The comparison rates used to derive the expected number of cases were the New Jersey average annual incidence rates for 1979 to 2006 for the total survey period and 1994 to 2006 for the 13-year period. The census block survey area age-sex-specific population was determined from the 2000 U.S. Census data (Census 2000).

The observed and expected numbers are evaluated by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal 1.0. An SIR less than 1.0 indicates that fewer cases are observed than expected. An SIR greater than 1.0 indicates that more cases than expected are observed.

Random fluctuations may account for some SIRs being higher or lower than 1.0. The statistical significance of deviations from SIR equal to 1.0 was evaluated using a 95% confidence interval (CI). The 95% CI was used to evaluate the probability that the SIR may be greater or less than 1.0 due to chance alone, and was based on the Poisson distribution (Breslow and Day 1987; Checkoway et al. 1989). If the confidence interval includes 1.0, then the estimated SIR is not considered to be statistically significantly different than 1.0.

Results

Table 1 presents demographic information for the Pompton Lakes survey area. Based on the 2000 census data, a total of 1,623 people resided in the survey area (781 males and 842 females). The survey population represents 15.3% of the total Pompton Lakes population.

For the period 1979 through 2006, a total 1,567 malignant incident cancer cases were diagnosed in Pompton Lakes residents. Table 2 presents the cancer cases in the survey area by sex and age group. A total of 254 cancer cases resided in the survey area, representing 16.2% of the total cases in Pompton Lakes. There were slightly more female cases than males. Nearly 75% of the cases were diagnosed at age 60 or older. No cases were identified in residents under 20 years of age.

Table 3 presents cancer incidence in the survey area by cancer type. The most frequently diagnosed cancer types include breast, colorectal, lung, and prostate, representing nearly 50% of all incident cancers in the survey area. The frequency of these cancer types is consistent with New Jersey statewide cancer incidence data.

Table 4 presents the standardized incidence ratio (SIRs) results for the survey area by sex for the 28-year survey period. Based on average state rates, overall cancer incidence was found to be close to the expected for males and slightly higher than expected for females. The only statistically significantly elevated SIR was for kidney cancer in females (SIR=3.15; 95% CI=1.26, 6.49) based on seven cases. Kidney cancer in males was similar to the expected number. One of the female cases with kidney cancer did not appear to live directly above the groundwater plume based on the New Jersey Department of Environmental Protection (NJDEP) groundwater contamination map presented to the community in March 2009. Brain/CNS cancer, a cancer of concern to residents, was found to be close to the expected for both males and females. None of the SIRs were statistically significantly low.

Since population data by census block was only available for the year 2000, SIRs were recalculated for the 13-year period (1994-2006) bounding the census year. Table 5 presents the 13-year analysis results. Overall cancer incidence was found to be close to the expected for males, but slightly higher than expected for females, approaching statistical significance (SIR=1.27; 95% CI=0.99, 1.60). The only statistically significantly elevated SIR was for NHL cancer in males (SIR=2.67; 95% CI=1.07, 5.50) based on seven cases. One of the male cases with NHL did not appear to live directly above the groundwater plume based on the NJDEP groundwater contamination map. NHL in females was slightly higher than expected, though not statistically elevated. Kidney cancer in females, while not statistically significantly elevated, remained more than three times higher than expected (SIR=3.27; 95% CI=0.88, 8.38) as found for the entire 28-year period.

Discussion

The purpose of this investigation was to evaluate cancer incidence in a population residing in the neighborhood above the Dupont groundwater contamination in Pompton Lakes. The occurrence of cancer (all sites combined) over the 28-year observation period was similar to the expected (compared to average state rates). Kidney cancer in females was statistically significantly higher than expected (SIR=3.2). In the more recent period (1994-2006), the risk of being diagnosed with kidney cancer for females remained three times higher than expected (SIR=3.3), though not statistically significant. However, kidney cancer in males was similar to the expected for the entire survey period and the most recent time. NHL in males was statistically significantly higher than expected (SIR=2.7) in the more recent 13-year period. NHL in females was similar to the expected.

While it appears that one case each of kidney cancer and NHL resided beyond the limit of the plume based on the 2009 NJDEP groundwater plume map, the extent of the plume is not static in time. Data indicate that activities to treat contaminated groundwater and re-inject treated water into the aquifer have decreased contaminant concentrations by an order of magnitude and reduced the size of the plume in the residential area (Corporate Remediation Group 2008). Consequently, since the maximum boundary of the plume through time cannot be determined, the homes of these two cases may have been over the plume sometime in the past. Additionally, testing of private wells adjacent to the facility property resulted in detection of heavy metals and chlorinated solvents (ATSDR 1994). By 1989, all homes with private wells in the area adjacent

to the facility were connected to the municipal water utility. There is a potential exposure associated with drinking water from these private wells prior to 1989.

Cancer is a group of more than 100 different diseases (i.e., cancer types and subtypes), each with its own set of risk factors. Consequently, any evaluation of potential risk factors and specific cancer types is complicated since most cancer types have more than one known cause or risk factor. Chlorinated solvents (especially TCE and PCE) have contaminated the groundwater below a number of homes adjacent to the Dupont property. Both TCE and PCE are classified as probable human carcinogens (Schottenfeld and Fraumeni 2006; NTP 2005). Epidemiological studies have found associations between esophageal cancer, cervical cancer, and NHL with PCE in occupational settings (Schottenfeld and Fraumeni 2006). TCE had been associated with kidney cancer and liver cancer in animal studies (ATSDR1997). Ecological studies of New Jersey populations have found associations between exposure to community drinking water contaminated with TCE and PCE and leukemia and NHL in females (Schottenfeld and Fraumeni 2006; ATSDR 1997).

Kidney cancer is the seventh most common newly diagnosed cancer type in New Jersey males and the tenth most common type in females, representing respectively about 800 and 500 new cases each year (NJDHSS 2009). Multiple epidemiologic studies have identified cigarette smoking as an established risk factor for kidney cancer (American Cancer Society 2009a; Schottenfeld and Fraumeni 2006). Other risk factors identified for kidney cancer include obesity, workplace exposures (asbestos, cadmium, some herbicides, benzene, and organic solvents, particularly TCE), hypertension, and genetic factors (American Cancer Society 2009a; Schottenfeld and Fraumeni 2006; Mayo Clinic 2009a).

Non-Hodgkin lymphoma is the sixth most common newly diagnosed cancer type in New Jersey males and the fifth most common type in females, representing respectively about 1,000 and 900 new cases each year (NJDHSS 2009). NHL is a clinically and etiologically diverse group with a number of histologically different forms. A variety of risk factors have been suggested for NHL including certain infections, autoimmune diseases, immunosuppressive drugs, high dose ionizing radiation, and exposure to certain chemicals (e.g., pesticides, insecticides, TCE and PCE) (American Cancer Society 2009b; Schottenfeld and Fraumeni 2006; Mayo Clinic 2009b).

A limitation of cancer studies of this type is the inability to assess past exposure levels in the population. Important information needed to assess a cause-effect relationship includes data on actual personal exposure to the contamination and other relevant risk factors over time. That is, who was exposed and who was not exposed and the magnitude of the exposure that did occur. Because personal exposure information does not exist, residential proximity over the contaminated plume was used as a surrogate measure for potential past environmental exposure. This was accomplished by analyzing the population living in a relatively small geographic area above the groundwater plume. Although proximity to the plume may be a reasonable surrogate for past environmental potential exposures at the time the study was designed, it is also unlikely that all of the residents in these areas were exposed to the contamination. This would result in misclassifying some of the study area as exposed when they are not. Additionally, the length of residence of each case is unknown, thereby potentially adding to exposure misclassification. The

consequence of exposure misclassification would be to bias the results toward not finding an association (i.e., no exposure-health outcome relationship).

Another interpretation problem is that cancer is a chronic disease that takes many years after exposure to reveal itself as a clinical disease. The information supplied by the NJSCR provides only an address at time of diagnosis for each case. No information is available on length of time an individual may have lived at the address before diagnosis. It is possible that some cases are new, short-term residents with little or no exposure to the site. Furthermore, former residents who moved out of the study area before diagnosis are not available for analysis. Population mobility cannot be accounted for in this analysis.

Additionally, when researchers independently examine statistical associations for a large number of comparisons, it is likely that some number of statistically elevated or low SIRs will occur by chance alone. While it is possible to statistically correct for this concern, opinions differ on whether such corrections are needed. In this analysis, confidence intervals are presented without adjustment for multiple comparisons.

The approach used for this descriptive cancer investigation was census-based. The population of the census blocks in Pompton Lakes and the State of New Jersey were reviewed in order to calculate age standardized incidence rate ratios for the study area. This census approach (ecologic design) is a practical surveillance or screening method for cancer incidence. Although this approach is well suited for providing a picture of cancer incidence in the specific localities, cause-effect relationships cannot be evaluated. Important information on potential risk factors (such as genetics, life style, environmental factors, occupation, etc.) that might explain the results were not available for analysis using this type of study design.

Conclusions and Recommendations

Overall cancer incidence (all cancers combined) was not elevated in the Pompton Lakes groundwater plume area. Kidney cancer was higher than expected in females, but similar to the expected in males. NHL was higher than expected in males during the most recent 13-year evaluation period. NHL in females was similar to expected throughout the survey period. The analyses adjusted for male/female differences in the incidence by using average state rates to calculate an expected number of cases. The different SIR findings by sex provide a conflict for interpreting these results.

This is a descriptive analysis of cancer incidence in a geographic area, and it does not provide evidence of or specific relationship to environmental contamination. However, potential exposures to TCE and PCE from the groundwater plume cannot be ruled out as a potential cause of the elevated kidney cancer and NHL cancers. The inconsistency between the SIR results for males and females for these cancers does not support a causal association with these potential environmental exposures. Other plausible explanations for the elevated SIRs include other unmeasured risk factors in the community (e.g., tobacco consumption or occupational exposures), or chance alone.

The NJDHSS and ATSDR should continue to meet with community representatives to determine the most appropriate health education materials and outreach strategies to inform the general population about the environmental issues related to the groundwater plume. Furthermore, residents above the groundwater plume can decrease their current and future exposures to these chemicals by participating in the sub-slab VOC remediation system program.

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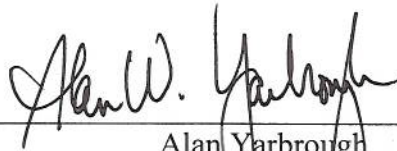
Certification

This health consultation was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This health consultation is in accordance with approved methodology and procedures existing at the time it was initiated.



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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.



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Figure and Tables

Figure 1. Pompton Lakes Survey Area.



Table 1. Pompton Lakes Survey Area Population from the U.S. Census Bureau.

Survey Area Population	Census Year 2000
Sex	
Male	781
Female	<u>842</u>
Total	1,623
Percent of Pompton Lakes	15.3%

Table 2. Pompton Lakes Survey Area, Malignant Cancer Incidence (1979-2006).

Characteristics*	Survey Area
Sex	
Male	121
Female	<u>133</u>
Total	254
Age at diagnosis	
0 – 19	0
20 – 29	6
30 – 39	9
40 – 49	22
50 – 59	28
60 – 69	57
70 – 79	76
80+	56

* Data are from the New Jersey State Cancer Registry, New Jersey Department of Health and Senior Services.

Table 3. Pompton Lakes Survey Area, Malignant Cancer Incidence (1979-2006).

Cancer Type*	Survey Area
Oralpharynx	<5
Esophagus	<5
Stomach	8
Small Intestine	<5
Colorectal	40
Liver	<5
Pancreas	5
Other Digestive	<5
Lung	32
Other Respiratory	<5
Bones and Joints	<5
Soft Tissue	<5
Melanoma	15
Other Skin	<5
Breast	28
Cervix	<5
Uterus	11
Ovary	9
Other Female Genital	<5
Prostate	27
Other Male Genital	<5
Bladder	8
Kidney	11
Other Urinary	0
Eye	0
Brain/CNS	<5
Endocrine	<5
Hodgkin Disease	<5
Non-Hodgkin Lymphoma	11
Myeloma	<5
Leukemia	<5
Miscellaneous/Other	10
Mesothelioma	<5
Kaposi's Sarcoma	<5

* Data are from the New Jersey State Cancer Registry, New Jersey Department of Health and Senior Services. Counts are suppressed when fewer than 5 cases to ensure confidentiality.

Table 4. Pompton Lakes Survey Area, SIR Analysis by Cancer Type and Sex (1979-2006).

Cancer Type	Sex	Observed	Expected	SIR ¹	95% CI	
					Lower	Upper
All Cancer	Male	121	126.1	0.96	0.80	1.15
	Female	133	117.2	1.13	0.95	1.34
Bladder	Male	<5	NR	0.40	0.11	1.03
	Female	<5	NR	1.17	0.31	2.99
Brain/CNS	Male	<5	NR	1.16	0.13	4.17
	Female	<5	NR	0.70	0.01	3.87
Colorectal	Male	17	17.4	0.97	0.57	1.56
	Female	23	16.6	1.39	0.88	2.08
Esophageal	Male	0	1.8	0.00	-	-
	Female	<5	NR	1.49	0.02	8.27
Kidney	Male	<5	NR	1.13	0.30	2.89
	Female	7	2.2	3.15 *	1.26	6.49
Leukemia	Male	<5	NR	0.86	0.17	2.53
	Female	0	2.7	0.00	-	-
Liver	Male	<5	NR	2.50	0.50	7.30
	Female	0	0.5	0.00	-	-
NHL	Male	8	4.9	1.64	0.71	3.23
	Female	<5	NR	0.70	0.14	2.03
Stomach	Male	<5	NR	1.21	0.33	3.10
	Female	<5	NR	1.90	0.51	4.86
Lung	Male	17	19.7	0.86	0.50	1.38
	Female	15	13.3	1.13	0.63	1.86
Bone/joint	Male	<5	NR	4.00	0.05	22.3
	Female	0	0.2	0.00	-	-
Breast	Female	28	34.6	0.81	0.55	1.17
Pancreas	Male	<5	NR	1.07	0.21	3.11
	Female	<5	NR	0.68	0.08	2.44

¹ Note: *= statistically high, **= statistically low, NR= not reported because observed <5. Data are from the New Jersey State Cancer Registry, New Jersey Department of Health and Senior Services.

Table 5. Pompton Lakes Survey Area, SIR Analysis by Cancer Type and Sex (1994-2006).

Cancer Type	Sex	Observed	Expected	SIR ¹	95% CI	
					Lower	Upper
All Cancer	Male	61	61.1	1.00	0.76	1.28
	Female	72	56.8	1.27	0.99	1.60
Bladder	Male	<5	NR	0.65	0.13	1.89
	Female	<5	NR	1.84	0.37	5.37
Brain/CNS	Male	<5	NR	1.18	0.02	6.59
	Female	0	0.7	0.00	-	-
Colorectal	Male	8	7.4	1.09	0.47	2.14
	Female	12	7.1	1.68	0.87	2.94
Esophageal	Male	0	0.8	0.00	-	-
	Female	<5	NR	3.24	0.04	18.04
Kidney	Male	<5	NR	1.05	0.12	4.57
	Female	<5	NR	3.27	0.88	8.38
Leukemia	Male	<5	NR	1.17	0.13	4.23
	Female	0	1.2	0.00	-	-
Liver	Male	<5	NR	2.72	0.31	9.81
	Female	0	0.2	0.00	-	-
NHL	Male	7	2.6	2.67 *	1.07	5.50
	Female	<5	NR	1.28	0.26	3.75
Stomach	Male	<5	NR	1.43	0.16	5.18
	Female	<5	NR	2.25	0.25	8.12
Lung	Male	7	8.5	0.82	0.33	1.70
	Female	8	7.1	1.13	0.49	2.22
Bone/joint	Male	0	0.1	0.00	-	-
	Female	0	0.1	0.00	-	-
Breast	Female	14	16.5	0.85	0.46	1.42
Pancreas	Male	<5	NR	0.74	0.01	4.13
	Female	<5	NR	0.68	0.01	3.81

¹ Note: *= statistically high, **= statistically low, NR= not reported because observed <5. Data are from the New Jersey State Cancer Registry, New Jersey Department of Health and Senior Services.