Agency for Toxic Substances and Disease Registry

Division of Health Studies

CANCER INCIDENCE IN POPULATIONS LIVING NEAR RADIOLOGICALLY CONTAMINATED SUPERFUND SITES IN NEW JERSEY

November 1999

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Agency for Toxic Substances
and Disease Registry
Atlanta, Georgia 30333

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ATLANTA, GEORGIA

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This report was partially supported by funds from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) trust fund provided to the New Jersey Department of Health and Senior Services through grant number U50/ATH282234-01 from the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. This document, presented in its entirety as submitted by the grantee, has not been edited to conform with agency guidelines.

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TABLE OF CONTENTS

Page

DISCLAIMER ii

TABLE OF CONTENTS iii

ABSTRACT 1

INTRODUCTION 3

METHODS 4
- Study Area and Population 4
- Case Subject Ascertainment and Study Period 5
- Data Analysis 6

RESULTS 7

DISCUSSION 9

CONCLUSIONS 12

REFERENCES 13

AUTHORS 15

TABLES 17

FIGURES 45

LIST OF TABLES

Page

Table 1a—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Total study area, 1979–1991 19

Table 1b—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. U.S. Radium focus area, 1979–1991 20

Table 1c—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Montclair/W. Orange focus area, 1979–1991 21

Table 1d—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Welsbach/General Gas Mantle focus area, 1979–1991 22

Table 2a—Cancer (malignancies) incidence, by type. Total study area, 1979–1991 23

Table 2b—Cancer (malignancies) incidence, by type. U.S. Radium focus area, 1979–1991 24

Table 2c—Cancer (malignancies) incidence, by type. Montclair/W. Orange focus area, 1979–1991 25

Table 2d—Cancer (malignancies) incidence, by type. Welsbach/General Gas Mantle focus area, 1979–1991 26

Table 3a—Comparison of the observed and expected cancer (malignancies) incidence. Total study area, 1979–1991 27

Table 3b—Comparison of the observed and expected cancer (malignancies) incidence. U.S. Radium focus area, 1979–1991 28

Table 3c—Comparison of the observed and expected cancer (malignancies) incidence. Montclair/W. Orange focus area, 1979–1991 29

Table 3d—Comparison of the observed and expected cancer (malignancies) incidence. Welsbach/General Gas Mantle focus area, 1979–1991 30

Table 4—Childhood cancer (malignancies) incidence, by type. Total study area, 1979–1991 31

LIST OF TABLES (Continued)

Page

Table 5a—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Total prime area, 1979–1991 32

Table 5b—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. U.S. Radium prime area, 1979–1991 33

Table 5c—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Montclair/W. Orange prime area, 1979–1991 34

Table 5d—Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Welsbach/General Gas Mantle prime area, 1979–1991 35

Table 6a—Cancer (malignancies) incidence, by type. Total prime area, 1979–1991 36

Table 6b—Cancer (malignancies) incidence, by type. U.S. Radium prime area, 1979–1991 37

Table 6c—Cancer (malignancies) incidence, by type. Montclair/W. Orange prime area, 1979–1991 38

Table 6d—Cancer (malignancies) incidence, by type. Welsbach/General Gas Mantle prime area, 1979–1991 39

Table 7a—Comparison of the observed and expected cancer (malignancies) incidence. Total prime area, 1979–1991 40

Table 7b—Comparison of the observed and expected cancer (malignancies) incidence. U.S. Radium prime area, 1979–1991 41

Table 7c—Comparison of the observed and expected cancer (malignancies) incidence. Montclair/W. Orange prime area, 1979–1991 42

Table 7d—Comparison of the observed and expected cancer (malignancies) incidence. Welsbach/General Gas Mantle prime area, 1979–1991 43

LIST OF FIGURES

Page

Figure 1—U.S. Radium and Montclair/Glen Ridge/W. Orange Sites 47

Figure 2—Welsbach/General Gas Mantle Sites 48

ABSTRACT

The relationship between cancer incidence and residence near radiologically contaminated hazardous waste sites in New Jersey was examined. Thirteen years of cancer incidence data (1979-1991) were collected for six towns contaminated from three Superfund sites: the U.S. Radium site in Orange; the Montclair/West Orange Radium Site located in Montclair, West Orange, and Glen Ridge; and the Welsbach and General Gas Mantle Contamination Sites located in Camden City and Gloucester City. Numerous properties within the six towns were contaminated by radium or thorium waste products dating back to the early twentieth century. The objective of the study was to evaluate whether the population residing closest to the contaminated areas had elevated cancer incidence.

The study area consisted of census blocks within approximately two city blocks of areas with documented contamination. The census blocks were grouped together into a total focus area for each Superfund site. Each total focus area was evaluated separately and combined with the other sites to form the total study area. In addition, a more restrictive study area designation (called the prime area) was developed to include the population residing within about one city block of the contaminated areas. Cancer data from the New Jersey State Cancer Registry, a population-based cancer incidence registry, was utilized for the study.

Standardized incidence ratios (SIRs) were calculated for all cancers combined and eleven site-specific cancers. Males and females were evaluated separately, and all races were combined in the analyses. Expected numbers were calculated using average state incidence rates and U.S. census data to estimate the population.

When compared to average state rates, the number of newly diagnosed cancers in the total study population was not higher than expected for all cancer combined or any of the eleven type-specific cancer groupings. The U.S. Radium focus area had significantly lower total cancer incidence (SIR=0.78; 95% confidence interval (CI)=0.66, 0.91) while the Welsbach/General Gas Mantle focus areas had significantly higher total cancer incidence (SIR=1.11; 95% CI=1.01, 1.22) and total cancer in males (SIR=1.18; 95% CI=1.03-1.36). The higher total cancer incidence for the Welsbach sites appears to be due to significantly higher lung cancer incidence in this population (all race-sex groups, SIR=1.39; 95% CI=1.11, 1.73; males only, SIR=1.59; 95% CI=1.20, 2.06). While total cancer incidence was unremarkable for the Montclair/West Orange Radium sites, total pancreatic cancer (SIR=1.77; 95% CI=1.03, 2.83) and thyroid cancer in females (SIR=2.72; 95% CI=1.09, 5.61) were significantly higher than expected.

When the study area was reduced to the prime areas, only one SIR remained significant. SIRs for the prime areas were similar to the total focus areas but were based on smaller observed and expected numbers. Lung cancer incidence for the total population near the Welsbach/General Gas Mantle sites remained significantly higher than expected (SIR=1.45; 95% CI=1.05, 1.95). Only two cases of thyroid cancer were diagnosed among persons residing in the total prime area, neither of which resided near the Montclair/West Orange sites.

Interpretation of these data should be done cautiously. Numerous limitations exist within the study design, including the inability to assess past individual exposure levels in the community leading to exposure misclassification, lack of knowledge of length of residence for case subjects, the potential impact of population migration, and the absence of information on other risk factors, such as occupational exposures or personal life-style habits.

In conclusion, this study found little consistency in the results across focus areas. Although lung cancer incidence was significantly elevated near the Welsbach/General Gas Mantle sites, and total pancreatic cancer and thyroid cancer in females were significantly elevated near the Montclair/West Orange sites, information on important confounding factors that might explain the elevations was not available for the analysis.

INTRODUCTION

During the late nineteenth and early twentieth centuries, a number of industrial facilities in New Jersey processed radiological ores and utilized the purified extracts for commercial products. Consequent to those operations, several of the manufacturing properties and surrounding off-site areas were significantly contaminated with radiological wastes. The U.S. Environmental Protection Agency (EPA) has placed three of the sites on the National Priority List, a listing of the most contaminated sites in the nation. The first site is U.S. Radium (formerly called Radium Luminous Materials Corporation; CERCLIS No. NJD9890654172) in Orange and West Orange, Essex County. The second site is known as the Montclair/West Orange Radium site (CERCLIS No. NJD980785653) and is comprised of several contaminated areas in Montclair, West Orange, and Glen Ridge, Essex County. The third site is known as the Welsbach and General Gas Mantle Contamination sites (CERCLIS No. NJD986620995) and is located in several sections of Camden City and Gloucester City, Camden County.

The U.S. Radium facility, which operated between 1915 and 1926, extracted and purified radium-226 from carnotite ore ($K_2(UO_2)_2(VO_4)_23H_2O$). The plant processed approximately two tons of ore daily, creating large quantities of process wastes and tailings containing radioisotopes. These wastes (approximately 1,600 tons) were stored on-site and subsequently transported to rural areas in Essex County and dumped with refuse as landfill. The facility manufactured watch and instrument dials, gun sights, and survey equipment that were coated with a luminescent paint produced from the processed ore (ATSDR, 1989 and 1997a). A wide area around the facility (as well as numerous satellite properties distant from the facility) was eventually contaminated with radioactive waste.

The Montclair/West Orange Radium Site is comprised of three distinct areas of radiological contamination. The first area consists of approximately 100 acres in Montclair and West Orange. The second area, located in West Orange, covers about 20 acres. The third area, located in Glen Ridge, consists of approximately 90 contaminated acres. The industrial activities at the U.S. Radium plant have been attributed as the source of contamination for these areas. Residential development occurred after contaminated fill from U.S. Radium was deposited in these areas (ATSDR 1995).

The Welsbach and General Gas Mantle Contamination sites were detected during an aerial gamma radiation survey contracted by the U.S. Environmental Protection Agency in May 1981. Elevated gamma levels were discovered at two former gas mantle factories and several residential areas in Camden County. At the time of the aerial survey, the factories had been closed for about 40 years. The residential properties appear to have been contaminated by off-site dumping of waste materials from the plants prior to residential development (ATSDR, 1997b).

Little information is available concerning the activities at the former General Gas Mantle Company, other than its production of incandescent gas mantles from approximately 1915 until 1941. It also used and resold radium, thorium, and mesothorium during that time period.

The Welsbach Company operated from 1896 to 1940 and also manufactured incandescent gas mantles, and at one point was the largest producer of gas mantles in the world. At its peak it produced about 250,000 mantles per day. The Welsbach manufacturing process used a highly purified solution of 99% thorium nitrate and 1% cerium nitrate as the lighting fluid. Monazite sands (which contain approximately 5% thorium as ThO_2) were the primary source of thorium and cerium. At the time, the extraction process and purification of thorium generated large quantities of byproducts with little or no commercial value. During the years that Welsbach and General Gas Mantle operated, ore tailings were used as landfill in the vicinity of the factories, which were located in relatively undeveloped marshlands along the Delaware River.

Environmental monitoring for gamma radiation, radon, and progeny indicate that monazite tailings and other byproducts were disposed as landfill at many properties in Camden City and Gloucester City. Some of these properties were later developed for residential housing (ATSDR, 1997b). The radiological contamination has existed for more than 50 years in these areas.

Public Health Assessments or Consultations have been prepared for each of the three Superfund sites. For all three sites, there is evidence that chronic exposure to radiological waste had occurred in the past which constituted a public health threat to residents of those areas. On the basis of this information, the Agency for Toxic Substances and Disease Registry (ATSDR) and the New Jersey Department of Health and Senior Services (NJDHSS) jointly agreed that a cancer statistics review for each of the sites needed to be conducted. The purpose of this investigation was to evaluate cancer incidence in populations living in relatively close proximity to areas contaminated with radiological industrial wastes.

METHODS

Study Area and Population

The study area for the Radiological Cancer Study was developed to include a large enough population to provide meaningful statistics and restrictive enough to include only those persons living relatively close to three Superfund sites with documented radiological contamination. The three Superfund sites include U.S. Radium site in Orange, the Montclair/Glen Ridge/West Orange contaminated areas, and the Welsbach and General Gas Mantle sites in Camden City and Gloucester City.

Census blocks with contaminated properties or census blocks located within approximately two city blocks of the areas with documented contamination were grouped together and designated as the total focus area for each site. Census blocks are geographic areas defined by the Bureau of the Census, U.S. Department of Commerce for the purpose of compiling demographic information. Each total focus area was evaluated separately and combined with one another to form the total study area. In addition, a more restrictive study area designation (called the prime area) was developed to include the population residing within about one city block of the contaminated areas (see Figures 1 and 2).

The study population consisted of all residents living in the specified census blocks. For the purpose of calculating statistics for this investigation, the 1990 federal population estimates (Bureau of the Census, U.S. Department of Commerce, 1990) were utilized for the census blocks. The total population for all five towns included in the study decreased by less than 0.5% between the 1980 to the 1990 Census surveys. Because the 1980 census block statistics were not available, the 1990 population figures provide the most representative estimate of the size and age structure of the studied population.

Case Subject Ascertainment and Study Period

The New Jersey State Cancer Registry was used for the ascertainment of cancer cases. The Cancer Registry, operated by the New Jersey Department of Health and Senior Services (NJDHSS), is a population-based cancer-incidence registry covering the entire state of New Jersey. By law, all cases of newly diagnosed cancers are reportable to the Registry (N.J.S.A. 26:2-104 et. seq.). In addition, the Registry has reporting agreements with the states of New York, Pennsylvania, Delaware and Florida. Information on New Jersey residents that are diagnosed in those states is supplied to the New Jersey State Cancer Registry. The Registry has been in operation since October 1, 1978.

The study period for this investigation was January 1, 1979, through December 31, 1991, thirteen full years of observation. A "case subject" was defined as an individual who was diagnosed with a new primary malignant cancer during the study period while residing in one of the selected census blocks.

The information for each newly diagnosed case available from the Cancer Registry is limited. The basic source for the Registry was documented information from the patient's medical record. The collected information includes demographic and medical data on each cancer patient. Variables used to analyze the level of cancer in the study area include: name, address at time of diagnosis, state municipality code, census tract code, primary cancer site, histology type, date of diagnosis, age at diagnosis, date of birth, race, sex, and NJDHSS Registry identification number. Each cancer is topographically and morphologically coded

using the second edition of the *International Classification of Disease for Oncology* (WHO, 1990).

Information on other risk factors such as occupational exposures or personal lifestyle habits are not available in the abstracted medical information used in this study. The potential risk factors that cannot be accounted for in the study design may vary within the study area or relative to the State as a whole.

To ensure that all possible cases for the study area were located, Registry data were requested for all cases identified as living in Orange, West Orange, Montclair, Glen Ridge, Gloucester City and Camden City. All case residential addresses were evaluated for study-area inclusion.

Data Analysis

Analyses were completed for all malignant cancer types combined and for select cancer types for the entire study area (i.e., all specified census blocks combined) and each Superfund site separately. The select cancer types analyzed include: bladder, brain and central nervous system, pancreas, lung and pleura, leukemia, non-Hodgkin's lymphoma, liver, bone, kidney, and female breast. The cancer types were jointly decided on through discussion by research staff at ATSDR and NJDHSS. Through the peer review process, it was suggested that thyroid cancer and cancer of the spleen be analyzed in addition to the other types. Thyroid cancer has been added to the analysis, however, cancer of the spleen was investigated but not analyzed because there were no cases in the study population. These cancer types were selected because they represent groupings that may be more sensitive to the effects of radiation exposure. Males and females were evaluated separately. All races were combined for the analyses.

Standardized incidence ratios (SIRs) were used for the quantitative analysis of cancer incidence in the study areas (Kelsey, Thompson and Evans, 1986; Breslow and Day, 1987). The SIR is calculated by dividing the observed number of cases (from the Registry) by an expected number of cases for the surveyed population during the time period reviewed.

SIR = observed cases ÷ expected cases

The expected number was derived by multiplying a comparison population's age-sex-specific 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 (1986-1988). This time period provides a sufficient number of cases statewide for stable age-sex-specific rates and is representative of statewide cancer incidence during the study period. The study area age-sex-specific population was determined from

Bureau of the Census, U.S. Department of Commerce, 1990 data. The 1990 population data was used because each municipality's population remained relatively stable through the 1980's and census block information was more readily available for the 1990 census. The age-specific population groups were 0-4, 5-17, 18-44, 45-64, and 65 or older. The formula for deriving the expected number of cases is shown below (where i represents each age-specific category).

$$\sum_{i=1}^{5} (\text{age-specific rate}_i) \times (\text{age-group population}_i)$$

Evaluation of the observed and expected numbers is accomplished by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal one (1.0). When the SIR is less than one, we conclude that fewer cases were observed than expected. Should the SIR be greater than one, then more cases than expected were observed.

Random fluctuations may account for some SIR deviations from 1.0. Statistical significance of deviations from SIR equal to 1.0 was evaluated using a 95% confidence interval (CI) (Breslow and Day, 1987). 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. Approximations of the upper and lower limits were calculated as follows (Breslow and Day, 1987; Checkoway, Pearce, and Crawford-Brown, 1989).

Lower limit of the SIR:

$$\text{Observed} \times \left[1 - \left(1 \div (9 \times \text{Observed})\right) - \left(Z_{\alpha/2} \div (3 \times \text{Observed}^{0.5})\right)\right]^3 \div \text{Expected}$$

Upper limit of the SIR:

$$(\text{Observed}+1) \times \left(1 \div (9 \times (\text{Observed}+1))\right) + \left(Z_{\alpha/2} \div (3 \times (\text{Observed}+1)^{0.5})\right)\Big]^3 \div \text{Expected}$$

If the confidence interval is 1.0, then the SIR is not considered to be significantly different than 1.0.

RESULTS

Tables 1a through 1d display the number of malignant incident cases by race, age-group, year of diagnosis, and sex for the total study area and the three focus areas. A total of

940 cancers were diagnosed in residents living in the total study area, with nearly equal division between the sexes. A majority of the cases (80.4%) were identified as white. Only six of the cases were in children under the age of 20. Cases appeared to be relatively evenly distributed throughout the study period.

Of the total study area cases, approximately 45% lived in the Welsbach/General Gas Mantle focus area, 39% in the Montclair/West Orange focus area, and 16% in the U.S. Radium focus area. Although the sex ratio was similar for each of the areas, the race of the cases differed sharply among focus areas: Welsbach/General Gas Mantle was nearly 93% white, Montclair/West Orange was nearly 79% white, and U.S. Radium was just over 50% white. Three of the six childhood cases resided in the U.S. Radium focus area.

Tables 2a through 2d present a description of the cases by cancer type and sex for the total study area and the focus areas separately. For males, the most frequent cancer type was lung and pleura (107) followed by prostate (83) and colorectal (65). For females, the most frequent cancer type was breast (142), followed by colorectal (81) and lung and pleura (43). The three most common cancer types were generally congruous across focal areas and consistent with New Jersey State cancer incidence data.

Tables 3a through 3d present standardized incidence ratio (SIR) results for the total study area and focus areas by total population and sex. Of the 34 SIRs calculated for the total study area (Table 3a), two were significantly lower than expected, bladder cancer in females (SIR=0.38; 95%CI=0.12, 0.89) and leukemia in females (SIR=0.38; 95% CI=0.10, 0.98), while none were significantly higher than expected.

For the U.S. Radium focus area (Table 3b), none of the SIRs were significantly elevated, while five were significantly lower than expected: all cancers combined for males (SIR=0.74; 95%CI=0.58, 0.94), females (SIR=0.80; 95%CI=0.63, 0.99) and total population (SIR=0.78; 95%CI=0.66, 0.91), lung and pleural cancer in females (SIR=0.27; 95%CI=0.05, 0.79), and non-Hodgkin's lymphoma in the total population (SIR=0.15; 95%CI=0.00, 0.81).

Pancreatic cancer in the total population (Table 3c) was significantly elevated for the Montclair/West Orange focus area (SIR=1.77; 95%CI=1.03, 2.83). Although pancreatic cancer was not significantly elevated for either of the sexes, the magnitude of the sex-specific SIRs was similar to the SIR for the total population. Total thyroid cancer (SIR=2.31; 95%CI=1.01, 4.56) and thyroid cancer in females (SIR=2.72; 95%CI=1.09, 5.61) were also significantly elevated. The rate of thyroid cancer in the total population appears to be driven by the incidence in the female population. None of the SIRs was significantly lower than expected for the Montclair/West Orange focus area.

Four of the SIRs were significantly elevated for the Welsbach/General Gas Mantle focus area (Table 3d): all cancers combined for both the total population (SIR=1.11; 95%CI=1.01, 1.22) and males (SIR=1.18; 95%CI=1.03, 1.36) and lung and pleural cancer for both the total population (SIR=1.39; 95%CI=1.11, 1.73) and males (SIR=1.59; 95%CI=1.20, 2.06). In both instances, the elevations found for the total population appear to be driven by the excess male incidence.

Table 4 presents the frequency distribution for children (under age 20) by sex and cancer type. A total of six cases of cancer were diagnosed in children living in the total study area. The expected number for this population was 4.2 cases over the 13 year study period. The observed and expected number of childhood cancer cases were not significantly different.

Tables 5 through 7 present the cancer incidence for the prime areas (within one city block of the contaminated sites). Approximately 37 percent (347 of 940 cases) of the total study area cancer incidence occurred in residents living closest to the contamination. Lung/pleura cancer incidence was significantly elevated for the total population in the Welsbach/General Gas Mantle prime area (SIR=1.45; 95% CI=1.05, 1.95), while none of the SIRs were significantly low.

DISCUSSION

The purpose of this investigation was to evaluate cancer incidence in populations living in relatively close proximity to areas contaminated with radiological industrial wastes. Based on average State rates, the number of newly diagnosed cancers in the total study population was not higher than expected for all cancers combined or any of the eleven type-specific groupings. While total cancer incidence was unremarkable for the Montclair/West Orange sites, total pancreatic cancer and thyroid cancer in females were significantly higher than expected. The U.S. Radium focus area had significantly lower total cancer incidence, while the Welsbach/General Gas Mantle areas had significantly higher total cancer incidence. The higher total cancer incidence for the Welsbach/General Gas Mantle areas appears to be due to the significantly higher lung cancer incidence in this population, especially in males.

When the study area was reduced to the prime areas, only one SIR remained significant. The magnitude of the SIRs for the prime areas were similar to those of the total focus areas but were based on smaller observed and expected numbers. Lung cancer for the total population in the prime area near the Welsbach/General Gas Mantle sites remained significantly higher than expected. No cases of thyroid cancer occurred in the prime areas of the Montclair/West Orange site.

The results of this analysis indicate that there were no consistent results across the three focus areas and relatively few significantly elevated cancer types. It is important to note that

although each of the focus areas had evidence of complex mixtures of radiologic isotopes (both uranium-238 and thorium-232 decay series), the relative amount of contaminants from each decay series differed at each of the sites due to the industrial processing of monazite sands (thorium-232) vs. carnotite ore (radium-226). However, each of the sites was known to present health risks from exposure to external sources of gamma radiation in soils and structural materials and to the inhalation of emitters of alpha radiation in contaminated air or suspended particles of contaminated dust.

All ionizing radiation can cause damage to organic molecules, especially DNA, and can, therefore, produce both mutagenic and carcinogenic effects. The probability of developing an adverse health effect, such as cancer, is a function of length, route, and magnitude of exposure. Although the magnitude of the potential exposure at each of the sites was generally relatively low, but above background, the potential length of exposure was long and completed exposure pathways were available to residents in each of the areas. However, there is little published data available to suggest which types of cancer may be impacted from low level exposure to radium-226 or thorium-232.

The main source of information on the health effects of radium deposited in human tissues are the U.S. cases of occupational exposure (mostly in radium chemists and dial painters, including U.S. Radium employees) and therapeutic exposure during treatment of spondylitis and tuberculosis (BEIR IV, 1988; BEIR V, 1990; ATSDR, 1990a). Malignant effects have been found for bone sarcomas (especially osteogenic sarcomas) and carcinomas of the perinasal sinuses and mastoid air cells. Increased risk of lung cancer has been observed among underground miners and quantitatively related to the inhalation of radon daughter products (Blot and Fraumeni, 1996). Radon-222 and radon-220 are daughter products of uranium-238 and thorium-232, the main contaminants at these sites. In the most definitive accumulation of scientific data gathered since 1988, the National Academy of Sciences (NAS) in its Health Effects of Exposure to Radon report (BEIR VI, 1999) noted that the data from radon studies in homes is consistent with studies of radon health effects in mines. NAS also concluded that no evidence exits that shows a threshold of exposure below which radon levels are harmless. Weak evidence exists for the induction of leukemia, although at doses far greater than those found occupationally or medically.

Studies of thorium workers have shown that breathing thorium dust may increase the risk of lung cancer (ATSDR 1997b). Follow-up of patients exposed to thorium dioxide during diagnostic radiology showed increased rates of liver cancers, bone sarcomas, and myeloproliferative diseases, including leukemia (BEIR IV, 1988; BEIR V, 1990).

Carcinogenic effects of radiation on the bone marrow, breast, thyroid, lung, stomach, colon, ovary, and other organs have been reported for atomic bomb survivors and are similar to findings reported for other irradiated human populations (BEIR V, 1990). With few

exceptions, however, the effects have been observed only at relatively high doses. Studies of populations chronically exposed to low-level radiation have not shown consistent or conclusive evidence of an associated increase in the risk of cancer.

Thyroid cancer was the first of the solid tumors noted to occur at increased frequency in atomic bomb survivors (BIER V, 1990). Increased thyroid cancer risk has also been reported among persons exposed to therapeutic x-rays and Marshall Islanders exposed to radioactive fallout. Females appear to be two to three times more susceptible than males to radiogenic and spontaneous thyroid cancer (Ron, 1996).

Since the exposure potential at each of the sites was to relatively low levels and differed by radiological isotope, consistent SIR findings across sites may not necessarily be expected. In any event, due to inherent limitations in this type of investigation, interpretations of these data should be done with caution.

A serious limitation of cancer studies of this type is the inability to assess past exposure levels in the population. The critical piece of information required to assure a meaningful evaluation of these data is actual personal exposure to the contamination over time; that is, who was exposed and who was not exposed and the magnitude of the exposure that did occur. Since personal exposure information does not exist, residential distance from the contaminated site was used as a surrogate measure for potential past exposure. This was accomplished by grouping the population living in the selected nearby census blocks into a potentially exposed study area. Although distance from the site may have been the best way to estimate past 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. 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 the null hypothesis of no effect.

Another interpretation problem is that cancer is a chronic disease that takes many years after exposure to manifest as clinical disease. The information supplied by the Cancer Registry provides only an address at time of diagnosis for each case subject. No information is available on length of time an individual may have lived at the address before diagnosis. It is possible that some case subjects are new, short-term residents with little or no exposure to the sites. Furthermore, former residents who have moved out of the study area just prior to diagnosis are not available for analysis. Population mobility cannot be accounted for in this study. The current study assumes that in- and out- migration of individuals with cancer will offset each other.

The approach utilized in this study was "census" based, i.e., the entire population of the study areas and the State of New Jersey were reviewed in order to calculate sex- and age-standardized incidence ratios (SIRs). This census approach (ecologic design) is a practical surveillance, or screening, method for cancer incidence. However, information on important individual risk factors, such as occupational exposures or personal lifestyle habits (e.g., smoking history) were not available for this evaluation. Therefore, these potential risk factors cannot be accounted for in this study design and could vary widely within the study area.

Although high-dose radiation has been identified as a risk factor for lung cancer, cigarette smoking remains the major known risk factor for this disease (NCI, 1996). Epidemiological studies of working populations have also identified asbestos, radon, chromium, inorganic arsenic, and chloromethyl ethers as contributing agents to the incidence of lung cancer. Little is known about the causes of pancreatic cancer, however, cigarette smoking has been the only established risk factor, with a twofold risk for smokers relative to nonsmokers (NCI, 1996).

CONCLUSIONS

In conclusion, total cancer incidence and all eleven specific cancer groupings for the entire study area were not significantly higher than expected when compared to average State incidence rates. Little consistency in the results was detected across focus areas and none of the Montclair/West Orange thyroid cases lived in the prime areas closest to the contamination.

Lung cancer incidence in the total study area and two of the focus areas was not higher than expected. However, lung cancer incidence was significantly higher than expected in the total population living near the Welsbach/General Gas Mantle sites. This higher rate appears to be driven by the elevated incidence in males at this focus area. When the prime study areas were evaluated, lung cancer incidence in the total population near Welsbach/General Gas Mantle remained significantly higher than expected. Lung cancer was not elevated in any of the other prime areas.

Pancreatic cancer incidence in the total study area and two of the focus areas was not higher than expected. Pancreatic cancer incidence was higher than expected in the total population living near the Montclair/West Orange sites. Thyroid cancer in females was higher than expected for the Montclair/West Orange sites. When the prime study areas were evaluated, neither pancreatic cancer nor thyroid cancer remained higher than expected in any of the prime areas.

Since there was little agreement in the results across the focus or prime study areas, it is not likely that the few elevations detected are related to site contamination. Consequently, no further follow-up of cancer incidence appears warranted at this time.

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TABLES

Table 1a. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Total study area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	26	39	65
1980	32	40	72
1981	40	33	73
1982	36	36	72
1983	44	43	87
1984	37	39	76
1985	40	41	81
1986	35	42	77
1987	38	33	71
1988	45	32	77
1989	26	30	56
1990	41	28	69
1991	31	33	64
Total	471	469	940
Age Group:			
0-9	0	1	1
10-19	3	2	5
20-34	9	27	36
35-49	31	56	87
50-64	140	137	277
65-79	209	178	387
80+	79	68	147
Race:			
White	379	377	756
All Others	92	89	181
Unknown	-	3	3

Table 1b. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. U.S. Radium focus area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	1	5	6
1980	2	10	12
1981	5	5	10
1982	5	5	10
1983	6	9	15
1984	10	9	19
1985	6	4	10
1986	5	8	13
1987	6	5	11
1988	7	5	12
1989	5	6	11
1990	5	5	10
1991	9	5	14
Total	72	81	153
Age Group:			
0-9	0	1	1
10-19	1	1	2
20-34	1	11	12
35-49	4	18	22
50-64	19	19	38
65-79	32	23	55
80+	15	8	23
Race:			
White	38	39	77
All Others	34	41	75
Unknown	-	1	1

Table 1c. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Montclair/W. Orange focus area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	15	9	24
1980	4	13	17
1981	16	18	34
1982	16	15	31
1983	17	20	37
1984	18	14	32
1985	15	16	31
1986	16	17	33
1987	12	11	23
1988	22	13	35
1989	13	7	20
1990	19	10	29
1991	9	13	22
Total	192	176	368
Age Group:			
0-9	0	0	0
10-19	1	0	1
20-34	4	4	8
35-49	11	17	28
50-64	55	61	116
65-79	84	67	151
80+	37	27	64
Race:			
White	153	137	290
All Others	39	38	77
Unknown	-	1	1

Table 1d. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Welsbach/General Gas Mantle focus area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	10	25	35
1980	26	17	43
1981	19	10	29
1982	15	16	31
1983	21	14	35
1984	9	16	25
1985	19	21	40
1986	14	17	31
1987	20	17	37
1988	16	14	30
1989	8	17	25
1990	17	13	30
1991	13	15	28
Total	207	212	419
Age Group:			
0-9	0	0	0
10-19	1	1	2
20-34	4	12	16
35-49	16	21	37
50-64	66	57	123
65-79	93	88	181
80+	27	33	60
Race:			
White	188	201	389
All Others	19	10	29
Unknown	-	1	1

Table 2a. Cancer (malignancies) incidence, by type. Total study area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	30	5	35
Bone and Joint	3	0	3
Brain/Central Nervous System	6	2	8
Breast	4	142	146
Cervix	-	19	19
Colorectal	65	81	146
Corpus uteri	-	34	34
Esophagus	7	2	9
Eye	0	1	1
Gallbladder	1	5	6
Hodgkin's Disease	2	3	5
Kidney	10	9	19
Larynx	17	3	20
Leukemia	14	4	18
Liver	3	4	7
Lung/Pleura	107	43	150
Myeloma	3	5	8
Oral/Pharynx	22	7	29
Other Digestive	1	0	1
Other Respiratory	2	2	4
Other Female Genital	-	2	2
Other Male Genital	1	-	1
Ovary	-	22	22
Non-Hodgkin's Lymphoma	16	9	25
Pancreas	17	12	29
Prostate	83	-	83
Skin	15	14	29
Small Intestine	0	2	2
Soft Tissue	5	3	8
Stomach	12	6	18
Testis	6	-	6
Thyroid	2	11	13
Other or Unknown Primary	17	17	34
Total	471	469	940

Table 2b. Cancer (malignancies) incidence, by type. U.S. Radium focus area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	4	2	6
Bone and Joint	2	0	2
Brain/Central Nervous System	1	0	1
Breast	0	28	28
Cervix	-	7	7
Colorectal	11	10	21
Corpus uteri	-	5	5
Esophagus	3	0	3
Eye	0	0	0
Gallbladder	0	2	2
Hodgkin's Disease	0	2	2
Kidney	0	0	0
Larynx	3	1	4
Leukemia	2	2	4
Liver	0	0	0
Lung/Pleura	22	3	25
Myeloma	1	1	2
Oral/Pharynx	2	0	2
Other Digestive	0	0	0
Other Respiratory	0	0	0
Other Female Genital	-	1	1
Other Male Genital	0	-	0
Ovary	-	3	3
Non-Hodgkin's Lymphoma	1	0	1
Pancreas	2	2	4
Prostate	12	-	12
Skin	1	3	4
Small Intestine	0	1	1
Soft Tissue	0	3	3
Stomach	0	2	2
Testis	0	-	0
Thyroid	1	2	3
Other or Unknown Primary	4	1	5
Total	72	81	153

Table 2c. Cancer (malignancies) incidence, by type. Montclair/W. Orange focus area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	13	0	13
Bone and Joint	1	0	1
Brain/Central Nervous System	3	1	4
Breast	1	55	56
Cervix	-	5	5
Colorectal	26	32	58
Corpus uteri	-	13	13
Esophagus	1	1	2
Eye	0	1	1
Gallbladder	0	1	1
Hodgkin's Disease	1	1	2
Kidney	8	4	12
Larynx	3	0	3
Leukemia	5	1	6
Liver	2	2	4
Lung/pleura	29	14	43
Myeloma	0	1	1
Oral/Pharynx	10	2	12
Other Digestive	1	0	1
Other Respiratory	0	0	0
Other Female Genital	-	1	1
Other Male Genital	1	-	1
Ovary	-	11	11
Non-Hodgkin's Lymphoma	11	4	15
Pancreas	8	9	17
Prostate	46	-	46
Skin	8	3	11
Small Intestine	0	0	0
Soft Tissue	2	0	2
Stomach	4	1	5
Testis	3	-	3
Thyroid	1	7	8
Other or Unknown Primary	4	6	10
Total	192	176	368

Table 2d. Cancer (malignancies) incidence, by type. Welsbach/General Gas Mantle focus area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	13	3	16
Bone and Joint	0	0	0
Brain/Central Nervous System	2	1	3
Breast	3	59	62
Cervix	-	7	7
Colorectal	28	39	67
Corpus uteri	-	16	16
Esophagus	3	1	4
Eye	0	0	0
Gallbladder	1	2	3
Hodgkin's Disease	1	0	1
Kidney	2	5	7
Larynx	11	2	13
Leukemia	7	1	8
Liver	1	2	3
Lung/pleura	56	26	82
Myeloma	2	3	5
Oral/Pharynx	10	5	15
Other Digestive	0	0	0
Other Respiratory	2	2	4
Other Female Genital	-	0	0
Other Male Genital	0	-	0
Ovary	-	8	8
Non-Hodgkin's Lymphoma	4	5	9
Pancreas	7	1	8
Prostate	25	-	25
Skin	6	8	14
Small Intestine	0	1	1
Soft Tissue	3	0	3
Stomach	8	3	11
Testis	3	-	3
Thyroid	0	2	2
Other or Unknown Primary	9	10	19
Total	207	212	419

Table 3a. Comparison of the observed and expected cancer (malignancies) incidence. Total study area, 1979-1991.*

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	940	935.4	1.00	0.94 - 1.07
	Male	471	442.5	1.06	0.97 - 1.17
	Female	469	490.3	0.96	0.87 - 1.05
Bladder	Total	35	48.9	0.72	0.50 - 1.00
	Male	30	34.8	0.86	0.58 - 1.23
	Female	5	13.2	0.38 *	0.12 - 0.89
Bone and Joint	Total	3	1.9	1.56	0.31 - 4.57
	Male	3	1.0	3.16	0.64 - 9.24
	Female	0	1.0	-	-
Brain/CNS†	Total	8	13.6	0.59	0.25 - 1.16
	Male	6	7.3	0.82	0.30 - 1.79
	Female	2	6.3	0.32	0.04 - 1.15
Breast	Female	142	148.8	0.95	0.80 - 1.12
Kidney	Total	19	22.4	0.85	0.51 - 1.32
	Male	10	13.1	0.77	0.37 - 1.41
	Female	9	9.1	0.99	0.45 - 1.87
Leukemia	Total	18	23.0	0.78	0.46 - 1.24
	Male	14	12.3	1.14	0.62 - 1.91
	Female	4	10.5	0.38 *	0.10 - 0.98
Liver	Total	7	5.6	1.24	0.50 - 2.56
	Male	3	3.6	0.84	0.17 - 2.45
	Female	4	2.0	2.03	0.55 - 5.20
Lung/Pleura	Total	150	146.9	1.02	0.86 - 1.20
	Male	107	89.8	1.19	0.98 - 1.44
	Female	43	55.3	0.78	0.56 - 1.05
NHL§	Total	25	31.4	0.80	0.51 - 1.18
	Male	16	15.9	1.01	0.58 - 1.64
	Female	9	15.4	0.58	0.27 - 1.11
Pancreas	Total	29	24.4	1.19	0.80 - 1.71
	Male	17	11.3	1.50	0.88 - 2.41
	Female	12	13.0	0.92	0.48 - 1.61
Thyroid	Total	13	9.7	1.35	0.72 - 2.30
	Male	2	2.5	0.81	0.09 - 2.93
	Female	11	7.3	1.51	0.75 - 2.71

* (Statistically significant ($p < 0.05$): * = low).
† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

Table 3b. Comparison of the observed and expected cancer (malignancies) incidence. U.S. Radium focus area, 1979-1991.*

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	153	196.6	0.78 *	0.66 - 0.91
	Male	72	96.9	0.74 *	0.58 - 0.94
	Female	81	101.7	0.80 *	0.63 - 0.99
Bladder	Total	6	9.7	0.62	0.23 - 1.34
	Male	4	7.4	0.54	0.14 - 1.38
	Female	2	2.5	0.81	0.09 - 2.92
Bone and Joint	Total	2	0.5	4.13	0.46 -14.91
	Male	2	0.2	8.33	0.94 -30.08
	Female	0	0.3	-	-
Brain/CNS†	Total	1	3.3	0.31	0.00 - 1.71
	Male	1	1.8	0.56	0.01 - 3.10
	Female	0	1.4	-	-
Breast	Female	28	32.3	0.87	0.58 - 1.25
Kidney	Total	0	4.8	-	-
	Male	0	2.9	-	-
	Female	0	1.9	-	-
Leukemia	Total	4	5.0	0.80	0.22 - 2.06
	Male	2	2.8	0.70	0.08 - 2.54
	Female	2	2.1	0.94	0.11 - 3.39
Liver	Total	0	1.2	-	-
	Male	0	0.8	-	-
	Female	0	0.4	-	-
Lung/Pleura	Total	25	30.3	0.82	0.53 - 1.22
	Male	22	19.6	1.12	0.70 - 1.70
	Female	3	11.1	0.27 *	0.05 - 0.79
NHL§	Total	1	6.9	0.15 *	0.00 - 0.81
	Male	1	3.7	0.27	0.00 - 1.49
	Female	0	3.1	-	-
Pancreas	Total	4	4.8	0.83	0.22 - 2.12
	Male	2	2.5	0.82	0.09 - 2.95
	Female	2	2.4	0.83	0.09 - 3.01
Thyroid	Total	3	2.5	1.35	0.09 - 2.90
	Male	1	0.6	1.61	0.02 - 8.94
	Female	2	1.9	1.04	0.12 - 3.76

* (Statistically significant ($p < 0.05$): * = low).
† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

Table 3c. Comparison of the observed and expected cancer (malignancies) incidence. Montclair/W. Orange focus area, 1979-1991.*

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	368	362.2	1.02	0.91 - 1.13
	Male	192	170.7	1.12	0.97 - 1.30
	Female	176	189.9	0.93	0.79 - 1.07
Bladder	Total	13	19.2	0.68	0.36 - 1.16
	Male	13	13.6	0.96	0.51 - 1.64
	Female	0	5.2	-	-
Bone and Joint	Total	1	0.7	1.54	0.02 - 8.54
	Male	1	0.3	3.11	0.04 -17.32
	Female	0	0.3	-	-
Brain/CNS†	Total	4	5.0	0.81	0.22 - 2.07
	Male	3	2.6	1.14	0.23 - 3.34
	Female	1	2.3	0.43	0.01 - 2.41
Breast	Female	55	57.3	0.96	0.72 - 1.25
Kidney	Total	12	8.7	1.38	0.71 - 2.42
	Male	8	5.0	1.60	0.69 - 3.14
	Female	4	3.5	1.13	0.30 - 2.89
Leukemia	Total	6	8.6	0.70	0.25 - 1.52
	Male	5	4.6	1.10	0.35 - 2.56
	Female	1	4.0	0.25	0.00 - 1.40
Liver	Total	4	2.2	1.82	0.49 - 4.67
	Male	2	1.4	1.45	0.16 - 5.23
	Female	2	0.8	2.59	0.29 - 9.35
Lung/Pleura	Total	43	57.6	0.75	0.54 - 1.01
	Male	29	34.9	0.83	0.56 - 1.19
	Female	14	21.8	0.64	0.35 - 1.08
NHL§	Total	15	11.9	1.26	0.70 - 2.07
	Male	11	5.9	1.86	0.93 - 3.32
	Female	4	6.0	0.67	0.18 - 1.72
Pancreas	Total	17	9.6	1.77 **	1.03 - 2.83
	Male	8	4.4	1.82	0.78 - 3.58
	Female	9	5.2	1.74	0.79 - 3.31
Thyroid	Total	8	3.5	2.31 **	1.01 - 4.56
	Male	1	0.9	1.11	0.01 - 6.17
	Female	7	2.6	2.72 **	1.09 - 5.61

*(Statistically significant ($p < 0.05$): ** = high).
† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

Table 3d. Comparison of the observed and expected cancer (malignancies) incidence. Welsbach/General Gas Mantle focus area, 1979-1991.*

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	419	376.7	1.11 **	1.01 - 1.22
	Male	207	174.9	1.18 **	1.03 - 1.36
	Female	212	198.6	1.07	0.93 - 1.22
Bladder	Total	16	20.2	0.80	0.46 - 1.30
	Male	13	13.8	0.94	0.50 - 1.61
	Female	3	5.5	0.55	0.11 - 1.60
Bone and Joint	Total	0	0.8	-	-
	Male	0	0.4	-	-
	Female	0	0.4	-	-
Brain/CNS†	Total	3	5.4	0.55	0.11 - 1.61
	Male	2	2.9	0.70	0.08 - 2.51
	Female	1	2.5	0.39	0.01 - 2.20
Breast	Female	59	59.1	1.00	0.76 - 1.29
Kidney	Total	7	9.0	0.78	0.31 - 1.61
	Male	2	5.1	0.39	0.04 - 1.42
	Female	5	3.7	1.35	0.43 - 3.14
Leukemia	Total	8	9.4	0.85	0.37 - 1.68
	Male	7	4.9	1.43	0.57 - 2.94
	Female	1	4.4	0.23	0.00 - 1.27
Liver	Total	3	2.3	1.32	0.26 - 3.85
	Male	1	1.4	0.71	0.01 - 3.96
	Female	2	0.8	2.44	0.27 - 8.81
Lung/Pleura	Total	82	59.0	1.39 **	1.11 - 1.73
	Male	56	35.2	1.59 **	1.20 - 2.06
	Female	26	22.5	1.16	0.76 - 1.70
NHL§	Total	9	12.6	0.72	0.33 - 1.36
	Male	4	6.2	0.64	0.17 - 1.65
	Female	5	6.3	0.79	0.26 - 1.85
Pancreas	Total	8	10.0	0.80	0.35 - 1.58
	Male	7	4.5	1.57	0.63 - 3.24
	Female	1	5.4	0.18	0.00 - 1.02
Thyroid	Total	2	3.7	0.54	0.06 - 1.95
	Male	0	0.9	-	-
	Female	2	2.8	0.72	0.08 - 2.60

* (Statistically significant ($p < 0.05$): * = low, ** = high).
† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

Table 4. Childhood cancer (malignancies) incidence, by type. Total study area 1979-1991.

Cancer Type	Male	Female	Total
Bone and Joint	1	0	1
Leukemia	1	0	1
Lung/Pleura	1	0	1
Oral/Pharynx	0	1	1
Ovary	-	1	1
Soft Tissue	0	1	1
Total	3	3	6

Table 5a. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Total prime area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	6	17	23
1980	11	13	24
1981	14	9	23
1982	18	17	35
1983	16	12	28
1984	11	12	23
1985	21	24	45
1986	11	19	30
1987	17	13	30
1988	15	11	26
1989	7	11	18
1990	13	13	26
1991	7	9	16
Total	167	180	347
Age Group:			
0-9	0	0	0
10-19	1	2	3
20-34	3	13	16
35-49	13	19	32
50-64	56	52	108
65-79	70	68	138
80+	24	26	50
Race:			
White	131	145	276
All Others	36	34	70
Unknown	-	1	1

Table 5b. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. U.S. Radium prime area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	0	2	2
1980	1	4	5
1981	2	1	3
1982	2	3	5
1983	2	3	5
1984	7	1	8
1985	2	3	5
1986	2	6	8
1987	3	1	4
1988	5	1	6
1989	2	2	4
1990	2	2	4
1991	2	1	3
Total	32	30	62
Age Group:			
0-9	0	0	0
10-19	0	1	1
20-34	1	6	7
35-49	1	4	5
50-64	9	7	16
65-79	14	10	24
80+	7	2	9
Race:			
White	20	13	33
All Others	12	17	29
Unknown	-	-	-

Table 5c. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Montclair/W. Orange prime area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	3	1	4
1980	0	2	2
1981	3	5	8
1982	5	4	9
1983	3	3	6
1984	4	2	6
1985	6	7	13
1986	3	4	7
1987	3	2	5
1988	4	3	7
1989	1	0	1
1990	3	3	6
1991	1	2	3
Total	39	38	77
Age Group:			
0-9	0	0	0
10-19	1	0	1
20-34	0	0	0
35-49	3	5	8
50-64	10	16	26
65-79	21	9	30
80+	4	8	12
Race:			
White	23	26	49
All Others	16	11	27
Unknown	-	1	1

Table 5d. Characteristics of cancer (malignancies) incidence, by year of diagnosis, age group, race, and sex. Welsbach/General Gas Mantle prime area, 1979-1991.

	Male	Female	Total
Diagnosis Year:			
1979	3	14	17
1980	10	7	17
1981	9	3	12
1982	11	10	21
1983	11	6	17
1984	0	9	9
1985	13	14	27
1986	6	9	15
1987	11	10	21
1988	6	7	13
1989	4	9	13
1990	8	8	16
1991	4	6	10
Total	96	112	208
Age Group:			
0-9	0	0	0
10-19	0	1	1
20-34	2	7	9
35-49	9	10	19
50-64	37	29	66
65-79	35	49	84
80+	13	16	29
Race:			
White	88	106	194
All Others	8	6	14
Unknown	-	-	-

Table 6a. Cancer (malignancies) incidence, by type. Total prime area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	9	1	10
Bone and Joint	2	0	2
Brain/Central Nervous System	3	2	5
Breast	0	51	51
Cervix	-	7	7
Colorectal	23	30	53
Corpus uteri	-	13	13
Esophagus	2	2	4
Eye	0	0	0
Gallbladder	0	3	3
Hodgkin's Disease	1	1	2
Kidney	3	4	7
Larynx	4	1	5
Leukemia	5	1	6
Liver	1	2	3
Lung/Pleura	39	22	61
Myeloma	2	2	4
Oral/Pharynx	8	4	12
Other Digestive	0	0	0
Other Respiratory	2	0	2
Other Female Genital	-	2	2
Other Male Genital	0	-	0
Ovary	-	8	8
Non-Hodgkin's Lymphoma	5	4	9
Pancreas	7	3	10
Prostate	30	-	30
Skin	6	6	12
Small Intestine	0	1	1
Soft Tissue	1	0	1
Stomach	5	4	9
Testis	2	-	2
Thyroid	0	2	2
Other or Unknown Primary	7	4	11
Total	167	180	347

Table 6b. Cancer (malignancies) incidence, by type. U.S. Radium prime area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	3	1	4
Bone and Joint	1	0	1
Brain/Central Nervous System	1	0	1
Breast	0	12	12
Cervix	-	2	2
Colorectal	7	4	11
Corpus uteri	-	1	1
Endocrine	0	1	1
Esophagus	1	0	1
Eye	0	0	0
Gallbladder	0	2	2
Hodgkin's Disease	0	1	1
Kidney	0	0	0
Larynx	0	0	0
Leukemia	1	0	1
Liver	0	0	0
Lung/Pleura	7	0	7
Myeloma	1	0	1
Oral/Pharynx	1	0	1
Other Digestive	0	0	0
Other Respiratory	0	0	0
Other Female Genital	-	1	1
Other Male Genital	0	-	0
Ovary	-	1	1
Non-Hodgkin's Lymphoma	0	0	0
Pancreas	2	1	3
Prostate	5	-	5
Skin	1	0	1
Small Intestine	0	1	1
Soft Tissue	0	0	0
Stomach	0	1	1
Testis	0	-	0
Thyroid	0	1	1
Other or Unknown Primary	1	1	2
Total	32	30	62

Table 6c. Cancer (malignancies) incidence, by type. Montclair/W. Orange prime area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	1	0	1
Bone and Joint	1	0	1
Brain/Central Nervous System	1	1	2
Breast	0	10	10
Cervix	-	1	1
Colorectal	4	11	15
Corpus uteri	-	1	1
Esophagus	0	1	1
Eye	0	0	0
Gallbladder	0	0	0
Hodgkin's Disease	0	0	0
Kidney	1	1	2
Larynx	0	0	0
Leukemia	1	0	1
Liver	0	0	0
Lung/Pleura	6	5	11
Myeloma	0	0	0
Oral/Pharynx	2	0	2
Other Digestive	0	0	0
Other Respiratory	0	0	0
Other Female Genital	-	1	1
Other Male Genital	0	-	0
Ovary	-	3	3
Non-Hodgkin's Lymphoma	3	1	4
Pancreas	2	1	3
Prostate	13	-	13
Skin	1	1	2
Small Intestine	0	0	0
Soft Tissue	0	0	0
Stomach	1	0	1
Testis	1	-	1
Thyroid	0	0	0
Other or Unknown Primary	1	0	1
Total	39	38	77

Table 6d. Cancer (malignancies) incidence, by type. Welsbach/General Gas Mantle prime area, 1979-1991.

Cancer Type	Male	Female	Total
Bladder	5	0	5
Bone and Joint	0	0	0
Brain/Central Nervous System	1	1	2
Breast	0	29	29
Cervix	-	4	4
Colorectal	12	15	27
Corpus Uteri	-	11	11
Esophagus	1	1	2
Eye	0	0	0
Gallbladder	0	1	1
Hodgkin's Disease	1	0	1
Kidney	2	3	5
Larynx	4	1	5
Leukemia	3	1	4
Liver	1	2	3
Lung/Pleura	25	17	42
Myeloma	1	2	3
Oral/Pharynx	5	4	9
Other Digestive	0	0	0
Other Respiratory	3	0	3
Other Female Genital	-	0	0
Other Male Genital	0	-	0
Ovary	-	4	4
Non-Hodgkin's Lymphoma	2	3	5
Pancreas	3	1	4
Prostate	12	-	12
Skin	4	5	9
Small Intestine	0	0	0
Soft Tissue	1	0	1
Stomach	4	3	7
Testis	1	-	1
Thyroid	0	1	1
Other or Unknown Primary	5	3	8
Total	96	112	208

Table 7a. Comparison of the observed and expected cancer (malignancies) incidence. Total prime area, 1979-1991.

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	347	344.0	1.01	0.91 - 1.12
	Male	167	161.2	1.04	0.88 - 1.21
	Female	180	180.7	1.00	0.86 - 1.15
Bladder	Total	10	17.9	0.56	0.27 - 1.03
	Male	9	12.6	0.71	0.33 - 1.35
	Female	1	4.9	0.21	0.00 - 1.15
Bone and Joint	Total	2	0.7	2.76	0.31 - 9.95
	Male	2	0.4	5.47	0.61 -19.74
	Female	0	0.4	-	-
Brain/CNS†	Total	5	5.1	0.98	0.32 - 2.30
	Male	3	2.7	1.09	0.22 - 3.20
	Female	2	2.3	0.86	0.10 - 3.12
Breast	Female	51	54.8	0.93	0.69 - 1.22
Kidney	Total	7	8.3	0.85	0.34 - 1.74
	Male	3	4.8	0.63	0.13 - 1.83
	Female	4	3.4	1.19	0.32 - 3.04
Leukemia	Total	6	8.5	0.71	0.26 - 1.54
	Male	5	4.6	1.10	0.35 - 2.56
	Female	1	3.9	0.26	0.00 - 1.44
Liver	Total	3	2.1	1.45	0.29 - 4.24
	Male	1	1.3	0.76	0.01 - 4.25
	Female	2	0.7	2.75	0.31 - 9.94
Lung/Pleura	Total	61	54.1	1.13	0.86 - 1.45
	Male	39	32.8	1.19	0.85 - 1.63
	Female	22	20.4	1.08	0.67 - 1.63
NHL§	Total	9	11.6	0.78	0.36 - 1.48
	Male	5	5.8	0.86	0.28 - 2.00
	Female	4	5.7	0.70	0.19 - 1.80
Pancreas	Total	10	9.0	1.12	0.53 - 2.05
	Male	7	4.1	1.70	0.68 - 3.50
	Female	3	4.8	0.63	0.13 - 1.83
Thyroid	Total	2	3.6	0.56	0.06 - 2.03
	Male	0	0.9	-	-
	Female	2	2.7	0.75	0.08 - 2.72

† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

Table 7b. Comparison of the observed and expected cancer (malignancies) incidence. U.S. Radium prime area, 1979-1991.

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	62	68.3	0.91	0.70 - 1.16
	Male	32	31.3	1.02	0.70 - 1.44
	Female	30	36.5	0.82	0.55 - 1.17
Bladder	Total	4	3.3	1.21	0.33 - 3.10
	Male	3	2.3	1.29	0.26 - 3.77
	Female	1	0.9	1.13	0.01 - 6.28
Bone and Joint	Total	1	0.2	5.60	0.07 -31.16
	Male	1	0.1	11.15	0.15 -62.04
	Female	0	0.1	-	-
Brain/CNS†	Total	1	1.2	0.85	0.01 - 4.72
	Male	1	0.7	1.52	0.02 - 8.44
	Female	0	0.5	-	-
Breast	Female	12	11.6	1.03	0.53 - 1.80
Kidney	Total	0	1.7	-	-
	Male	0	1.0	-	-
	Female	0	0.7	-	-
Leukemia	Total	1	1.8	0.57	0.01 - 3.19
	Male	1	1.0	1.03	0.01 - 5.72
	Female	0	0.8	-	-
Liver	Total	0	0.4	-	-
	Male	0	0.3	-	-
	Female	0	0.1	-	-
Lung/Pleura	Total	7	10.5	0.67	0.27 - 1.37
	Male	7	6.4	1.10	0.44 - 2.27
	Female	0	4.0	-	-
NHL§	Total	0	2.4	-	-
	Male	0	1.3	-	-
	Female	0	1.1	-	-
Pancreas	Total	3	1.7	1.82	0.37 - 5.33
	Male	2	0.8	2.56	0.29 - 9.23
	Female	1	0.9	1.17	0.02 - 6.50
Thyroid	Total	1	0.9	1.09	0.01 - 6.05
	Male	0	0.2	-	-
	Female	1	0.7	1.45	0.02 - 8.08

† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

Table 7c. Comparison of the observed and expected cancer (malignancies) incidence . Montclair/W. Orange prime areas, 1979-1991.

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	77	86.8	0.89	0.70 - 1.11
	Male	39	39.1	1.00	0.71 - 1.36
	Female	38	46.7	0.81	0.58 - 1.12
Bladder	Total	1	4.6	0.22	0.00 - 1.22
	Male	1	3.1	0.32	0.00 - 1.81
	Female	0	1.3	-	-
Bone and Joint	Total	1	0.2	6.20	0.08 -34.51
	Male	1	0.1	12.60	0.16 -70.09
	Female	0	0.1	-	-
Brain/CNS†	Total	2	1.2	1.65	0.18 - 5.94
	Male	1	0.6	1.57	0.02 - 8.75
	Female	1	0.6	1.76	0.02 - 9.79
Breast	Female	10	14.2	0.70	0.34 - 1.29
Kidney	Total	2	2.1	0.95	0.11 - 3.44
	Male	1	1.2	0.85	0.01 - 4.72
	Female	1	0.9	1.15	0.01 - 6.37
Leukemia	Total	1	2.1	0.49	0.01 - 2.70
	Male	1	1.1	0.93	0.01 - 5.20
	Female	0	1.0	-	-
Liver	Total	0	0.5	-	-
	Male	0	0.3	-	-
	Female	0	0.2	-	-
Lung/Pleura	Total	11	13.9	0.79	0.39 - 1.41
	Male	6	8.1	0.74	0.27 - 1.61
	Female	5	5.4	0.93	0.30 - 2.16
NHL§	Total	4	2.9	1.40	0.38 - 3.58
	Male	3	1.4	2.17	0.44 - 6.34
	Female	1	1.5	0.69	0.01 - 3.82
Pancreas	Total	3	2.3	1.31	0.26 - 3.84
	Male	2	1.0	1.97	0.22 - 7.12
	Female	1	1.3	0.80	0.01 - 4.45
Thyroid	Total	0	0.8	-	-
	Male	0	0.2	-	-
	Female	0	0.6	-	-

† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

Table 7d. Comparison of the observed and expected cancer (malignancies) incidence. Welsbach/General Gas Mantle prime area, 1979-1991. *

Cancer Type	Sex	Observed	Expected	SIR	95% CI
All Cancers	Total	208	188.9	1.10	0.96 - 1.26
	Male	96	90.8	1.06	0.86 - 1.29
	Female	112	97.5	1.15	0.95 - 1.38
Bladder	Total	5	10.1	0.50	0.16 - 1.16
	Male	5	7.2	0.69	0.22 - 1.62
	Female	0	2.7	-	-
Bone and Joint	Total	0	0.4	-	-
	Male	0	0.2	-	-
	Female	0	0.2	-	-
Brain/CNS†	Total	2	2.7	0.74	0.08 - 2.69
	Male	1	1.5	0.69	0.01 - 3.85
	Female	1	1.2	0.81	0.01 - 4.51
Breast	Female	29	29.0	1.00	0.67 - 1.44
Kidney	Total	5	4.5	1.11	0.36 - 2.60
	Male	2	2.6	0.76	0.09 - 2.75
	Female	3	1.8	1.64	0.33 - 4.80
Leukemia	Total	4	4.7	0.85	0.23 - 2.18
	Male	3	2.5	1.19	0.24 - 3.48
	Female	1	2.2	0.46	0.01 - 2.58
Liver	Total	3	1.1	2.62	0.53 - 7.67
	Male	1	0.7	1.37	0.02 - 7.64
	Female	2	0.4	4.95	0.56 -17.87
Lung/Pleura	Total	43	29.7	1.45 **	1.05 - 1.95
	Male	26	18.3	1.42	0.93 - 2.08
	Female	17	11.1	1.54	0.89 - 2.46
NHL§	Total	5	6.3	0.80	0.26 - 1.86
	Male	2	3.2	0.63	0.07 - 2.29
	Female	3	3.1	0.97	0.19 - 2.83
Pancreas	Total	4	5.0	0.80	0.21 - 2.04
	Male	3	2.3	1.29	0.26 - 3.78
	Female	1	2.7	0.37	0.00 - 2.07
Thyroid	Total	1	1.8	0.55	0.01 - 3.08
	Male	0	0.5	-	-
	Female	1	1.3	0.75	0.01 - 4.1

* (Statistically significant ($p < 0.05$): * = low, ** = high).
† CNS=central nervous system.
§ NHL=non-Hodgkin's lymphoma.

FIGURES

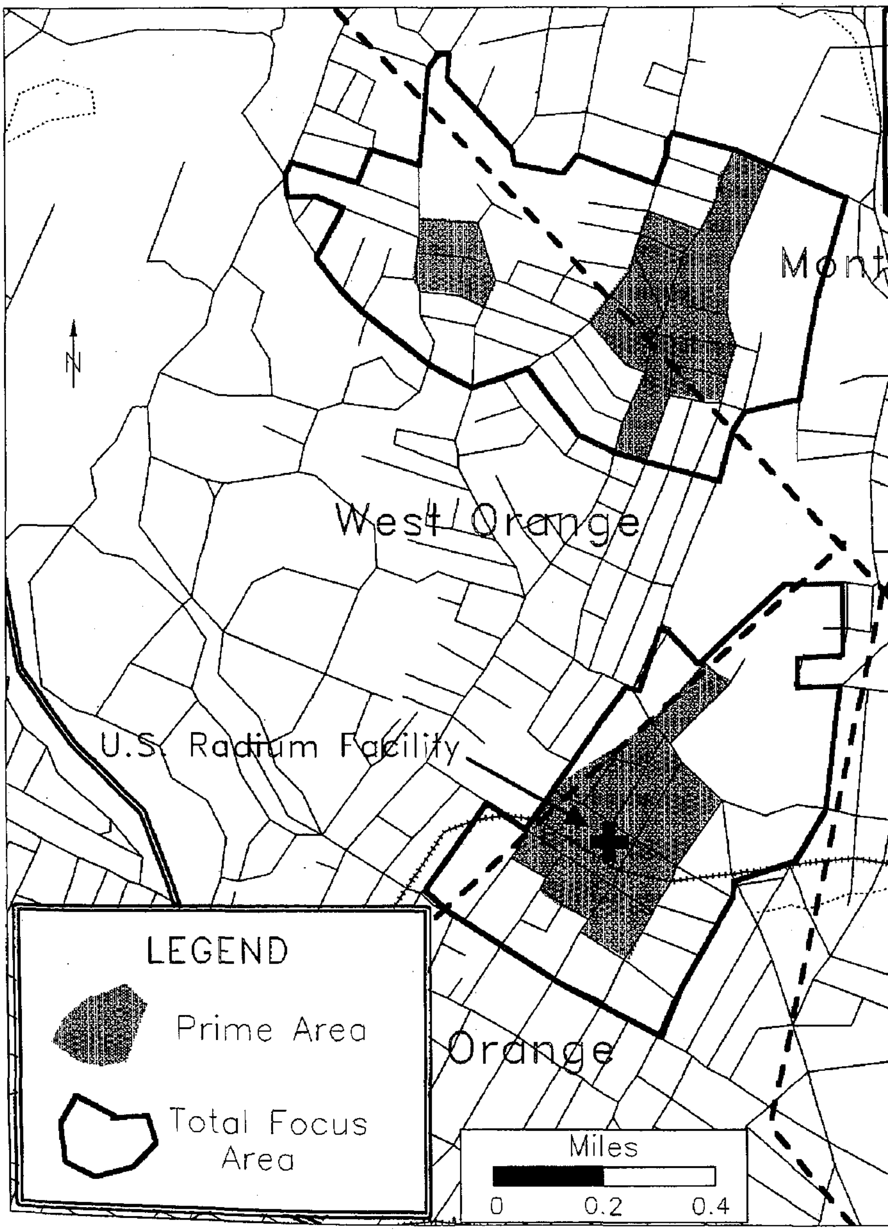
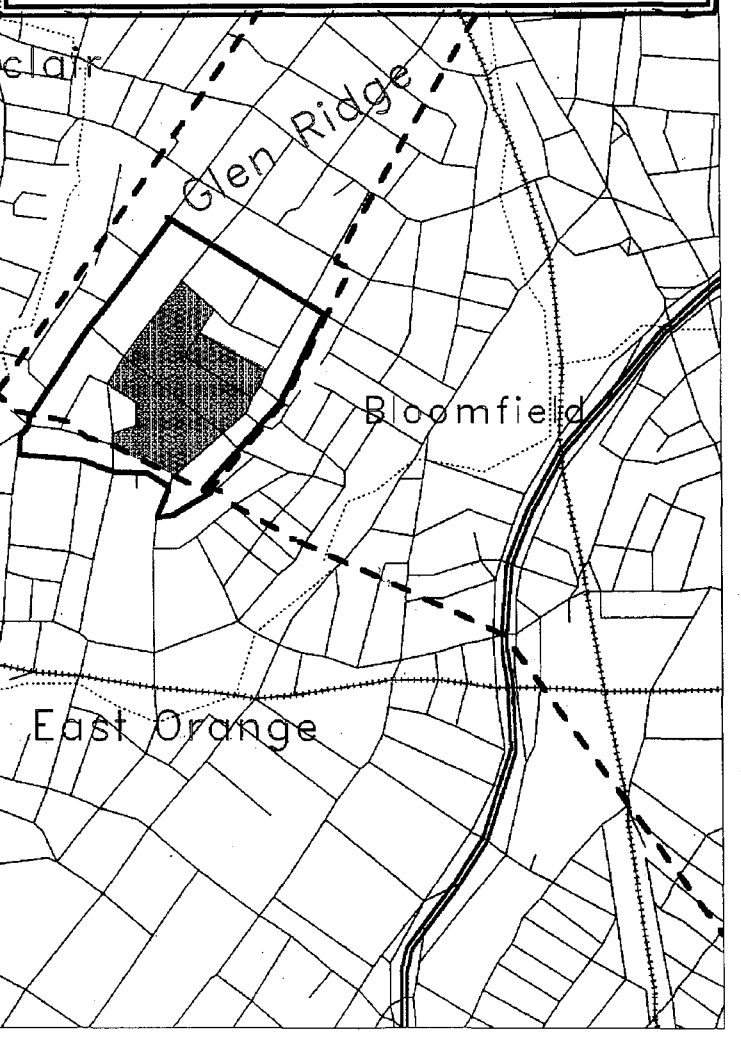

Montc
West Orange
U.S. Radium Facility
Orange
N
LEGEND
Prime Area
Total Focus Area
Miles
0
0.2
0.4

FIGURE 1
U.S. RADIUM AND MONCLAIR/
GLEN RIDGE/W. ORANGE SITES



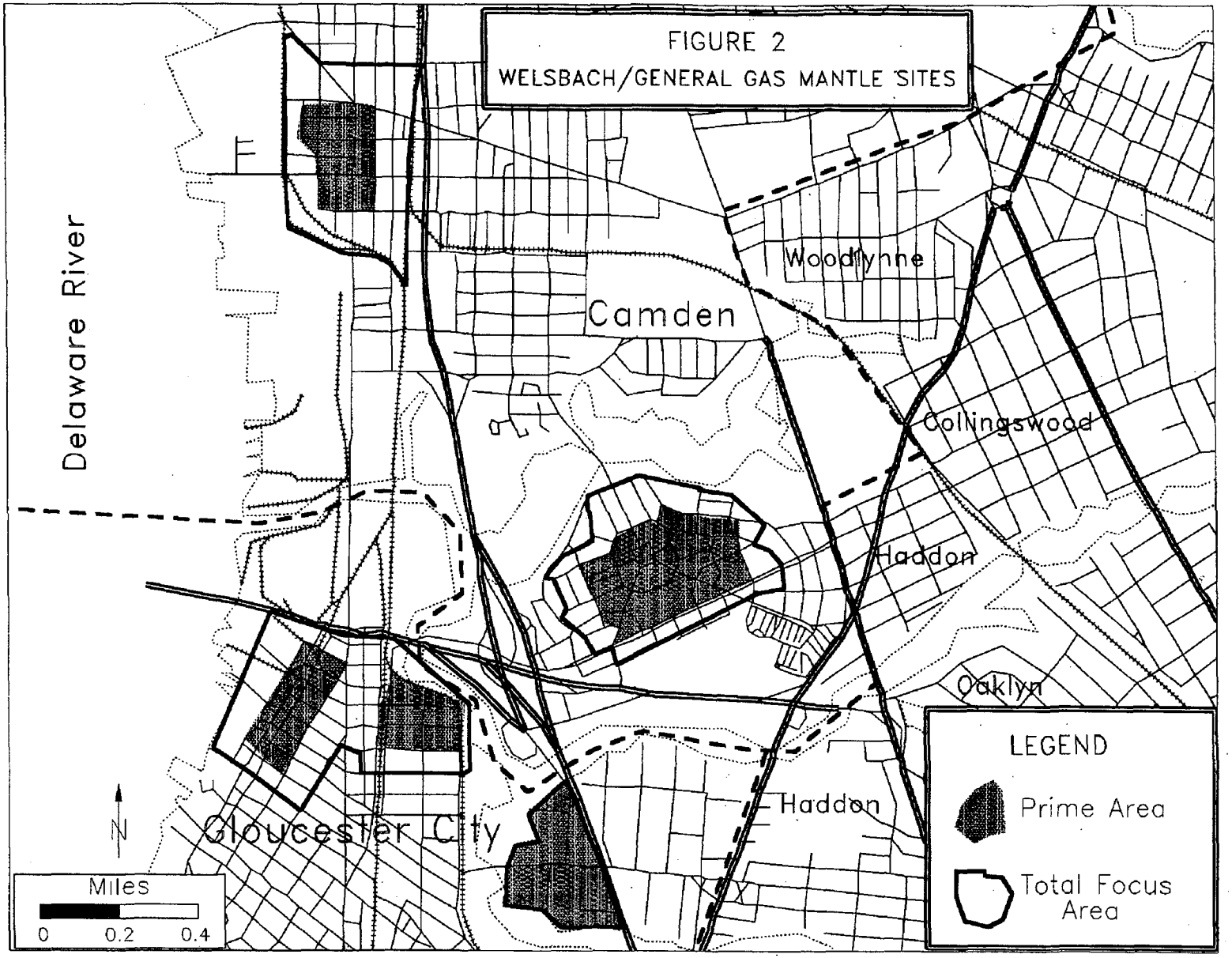


FIGURE 2
WELSBACH/GENERAL GAS MANTLE SITES
Delaware River
Camden
Woodlynne
Collingswood
Haddon
Oaklyn
Haddon
Gloucester City
N
Miles
0
0.2
0.4
LEGEND
Prime Area
Total Focus Area