

**Agency for Toxic  
Substances and  
Disease Registry**  
Division of Health Studies

**CANCER INCIDENCE IN THREE COMMUNITIES  
NEAR THE MAYWOOD AREA SUPERFUND SITES  
(BERGEN COUNTY), NEW JERSEY**

**MARCH 1998**



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

**Additional copies of this report are available from:  
National Technical Information Service, Springfield, Virginia  
1-800-553-6847 or 703-487-4650  
Request publication number PB98-128002**

**FINAL REPORT PRINTED BY**

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY  
ATLANTA, GEORGIA**

**CANCER INCIDENCE IN THREE COMMUNITIES NEAR THE MAYWOOD AREA  
SUPERFUND SITES (BERGEN COUNTY), NEW JERSEY**

**A Site-Specific Follow-Up Health Study**

**Prepared by Michael Berry, M.P.H.**

**New Jersey Department of Health and Senior Services  
Division of Environmental and Occupational Health Services  
Consumer and Environmental Health Services**

**MARCH 1998**

---

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 under Grant Number U50/ATU299746-01 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 revised or edited to conform with agency guidance.

---

## **DISCLAIMER**

Mention of the name of any company or product does not constitute endorsement by the Agency for Toxic Substances and Disease Registry, the U.S. Department of Health and Human Services, or the New Jersey Department of Health and Senior Services.

## CONTENTS

	<u>Page</u>
DISCLAIMER .....	ii
LIST OF TABLES .....	v
ABSTRACT .....	1
INTRODUCTION .....	3
METHODS .....	4
Study Area and Population .....	4
Cancer Case Ascertainment and Study Period .....	4
Data Analysis .....	5
RESULTS .....	6
Study Population .....	6
Cancer Case Ascertainment .....	6
SIR Analysis .....	7
DISCUSSION .....	8
RECOMMENDATIONS .....	10
REFERENCES .....	11
TABLES .....	13
FIGURE .....	25
APPENDIX .....	29

## LIST OF TABLES

	<u>Page</u>
Table 1.—Population Estimates for Maywood, Lodi, and Rochelle Park . . . . .	15
Table 2.—Cancer Incidence in Lodi, Maywood, and Rochelle Park . . . . .	16
Table 3.—Cancer Incidence by Study Area Location . . . . .	17
Table 4.—Age, Race, Year of Diagnosis and Sex of Cases in Study Area . . . . .	18
Table 5.—Cancer Incidence Within Study Area . . . . .	19
Table 6.—Standardized Incidence Ratios (SIR) for Study Area Comparison of Observed and Expected Cancer Incidence Using Average Annual State Rates . . . . .	20
Table 7.—Standardized Incidence Ratios (SIR) for Study Area Comparison of Observed and Expected Cancer Incidence Using SEER Average Annual Rates . . . . .	21
Table 8.—Standardized Incidence Ratios (SIR) for Non-Study Area Comparison of Observed and Expected Cancer Incidence Using Average Annual State Rates . . . . .	22
Table 9.—Standardized Incidence Ratios (SIR) for Non-Study Area Comparison of Observed and Expected Cancer Incidence Using SEER Average Annual Rates . . . . .	23
Table 10.—Age, Year of Diagnosis, and Type of Brain/CNS Cancer by Sex . . . . .	24

## ABSTRACT

The relationship between cancer incidence and residence near a hazardous waste site was examined. Ten years of cancer incidence data (1979-1988) were collected for three towns impacted by radiological and chemical contamination from the Maywood Area Superfund sites. Numerous properties within the three towns were contaminated by thorium and rare earth metals from processing operations dating back to 1916. 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 three census tracts and portions of two other census tracts. The size of the population in the study area was slightly greater than 15,000 people. Cancer data from the New Jersey Cancer Registry, a population based cancer incidence registry covering the entire state, 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. The expected number of cases were calculated from two separate referent populations: 1) state and 2) national cancer incidence rates.

When compared to the state rates, the only significantly elevated SIR for the study area was female brain/CNS cancer (SIR = 2.04; 95% CI = 1.02, 3.66). Lung cancer in females was significantly lower than expected (SIR = 0.69; 95% CI = 0.49, 0.95). When the referent group was the national rates, three SIRs were significantly elevated for males: all cancers combined (SIR = 1.13; 95% CI = 1.03, 1.24), bladder cancer (SIR = 1.55; 95% CI = 1.13, 2.08), and lung cancer (SIR = 1.28; 95% CI = 1.04, 1.54). Lung cancer in females remained significantly lower than expected (SIR = 0.70; 95% CI = 0.49, 0.96). Brain/CNS cancer in females was still twice the expected (SIR = 1.98; 95% CI = 0.99, 3.54) although no longer statistically significant.

Of note, brain and central nervous system cancer in females was double the expected amount. Although very little is known about the causes of brain cancer, studies have identified chemical and radiological contamination as potential risk factors. The current study was not designed to determine what risk factors could be responsible for cancer incidence in the area, it was only designed to evaluate whether cancer incidence was higher or lower than the referent population.

Interpretation of these data should be done very 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 the cases, the potential impact of population migration, and the absence of information on other risk factors such as occupational exposures or personal life-style habits.

Given the elevation of brain cancer in the study area, the Department of Health and Senior Services plans to continue surveillance of brain cancer in the study area. The Department has prepared an Addendum to this document containing an analysis of data through 1995. Future updates will be prepared periodically, as sufficient new information on cancer incidence becomes available.

Because the number of brain cancers is relatively small, it is not feasible to conduct studies to determine which etiologic factors are responsible for this case series. Larger epidemiologic studies are needed, especially directed on a national scale, to better elucidate the risk factors for brain cancer, so that effective preventive measures can be taken. Consequent to the results of this investigation, New Jersey data has been added to a multistate federal study of brain cancer in relation to residence near hazardous waste sites.



## **CANCER INCIDENCE IN THREE COMMUNITIES NEAR THE MAYWOOD AREA SUPERFUND SITES (BERGEN COUNTY), NEW JERSEY**

### **INTRODUCTION**

The following report describes a cancer investigation conducted by the New Jersey Department of Health and Senior Services (NJDHSS) in response to recommendations of the federal Agency for Toxic Substances and Disease Registry (ATSDR) for a health statistics review of the population living near the Maywood Area Superfund sites.

The Maywood site encompasses all properties located in Maywood, Rochelle Park, and Lodi, Bergen County, New Jersey (USDOE, 1990), that became contaminated as a result of industrial processing operations conducted by the former Maywood Chemical Works. These properties include the Stepan Company (formally the Maywood Chemical Company) property, the United States Department of Energy's (USDOE) Maywood Interim Storage site (MISS), the Ballod property, the Scanel site, the Sears warehouse and adjacent commercial, residential, and governmental properties.

The Maywood Chemical Works extracted thorium and rare earth metals from monazite ore (12% thorium and 1% uranium) from 1916 until 1956 for the manufacture of gas lantern mantles. All processed wastes that were generated were pumped to diked, unlined lagoons west of the property (now the Ballod property) and consisted mainly of a slurry of thorium-phosphorus. Some of the waste was used off-site by residents as mulch and fill dirt (ATSDR, 1992). Waste was also spread during the construction of the New Jersey Route 17 and by water runoff to the old Lodi Brook. As a result, over the years the Maywood site has contaminated much of the local area with radioactive and chemical wastes (ATSDR, 1990).

In 1980, testing by the New Jersey Department of Environmental Protection and the Nuclear Regulatory Commission first revealed extensive low level radiological contamination at several on-site and off-site locations (ATSDR, 1990). In 1983 the Maywood site was listed on the United States Environmental Protection Agency's (USEPA) National Priority List (NPL), and later was assigned to the USDOE's Formerly Utilized Sites Remedial Action Program (FUSRAP) by the Energy and Water Appropriations Act of 1984.

Radiological contamination (particularly thorium-232 and radium-226) have been documented extensively in the area. In addition, chemical contamination has been detected on the properties and on numerous off-site locations. The chemical contaminants found include (but are not limited to): gasoline, benzene, methylene chloride, trichloroethylene, tetrachloroethylene, vinyl chloride, and heavy metals (especially chromium, lead, mercury, arsenic, and cadmium) (ATSDR, 1990). Furthermore, there is evidence of ground water contamination at the MISS property and 11 public water wells in Lodi. The 11 public wells have subsequently been closed and listed separately on the NPL. Subsequent USEPA investigation of the Lodi wells determined that the radionuclide contamination was naturally occurring and the chemical contamination posed no unacceptable risk

since the worst contaminated wells were already closed. Consequently, USEPA issued a “No Action” remedy for the Lodi Municipal Wells (USEPA, 1993). The source of the groundwater contamination remains unknown, but appears to be part of a regional problem.

Community members have expressed concerns about past and potential current exposures to the radioactive and chemical waste and their effect on health, especially cancer. A health assessment of the site conducted by NJDHSS's Consumer and Environmental Health Services (CEHS) in 1990 concluded that contaminant concentrations found at the site posed a potential risk to the public that could result in adverse health consequences (ATSDR, 1990). Because of the possible human exposure to on-site and off-site contamination, the Maywood site was recommended for follow-up health activities by ATSDR. In response to this recommendation, the NJDHSS proposed a systematic review of cancer in the area. The purpose of this study was to evaluate whether the population residing closest to the contamination had higher cancer incidence rates than the state as a whole.

## **METHODS**

### **STUDY AREA AND POPULATION**

The study area for the Maywood 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 the areas of contamination. In order to accomplish this, three census tracts and portions of two others located proximal to the contamination were grouped together and defined as the study area. Census tracts are geographic areas defined by the U.S. Census Bureau for the purpose of compiling demographic information. The census tracts selected include 332 and 333 in Maywood, 301 in Lodi, the upper section of 303 north of Route 46 in Lodi, and part of 500.97 east of Rochelle Avenue in Rochelle Park. These areas contain all the sites of known contamination (Figure 1).

The study population consists of all residents living in the specified census tracts. For the purpose of calculating statistics for this investigation, the 1980 and 1990 federal population estimates (U.S. Census Bureau, 1980 and 1990) were utilized for the census tracts. These population figures were compiled within the study time period and provide the most representative estimate of the size and age structure of the studied population.

### **CANCER CASE ASCERTAINMENT AND STUDY PERIOD**

The New Jersey Cancer Registry was used for the ascertainment of cancer cases. The Cancer Registry, operated by the New Jersey Department of Health and Senior Services, is a population based cancer incidence registry covering the entire state of New Jersey. By law, all individuals with newly diagnosed cancers are reportable to the Registry. In addition, the Registry has reporting agreements with neighboring states, New York, Pennsylvania, Delaware and Florida, where

information on New Jersey residents that are diagnosed in those states will be supplied to the New Jersey 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, 1988, ten full years of observation. A "case" was defined as an individual residing in one of the selected census tracts and was diagnosed with a new primary malignant cancer during the study period.

The information for each newly diagnosed case available from the Cancer Registry is limited. The basic source is 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.

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 Lodi, Maywood, and Rochelle Park. Cases with known census tract codes were easily evaluated for study area inclusion. However, cases without census tract codes required identification on street maps. The remaining unlocatable cases were coded as cases of unknown location.

## **DATA ANALYSIS**

Analysis was completed for all cancer types combined and for select cancer types for the entire study area (i.e., the specified census tracts combined). The select cancer types analyzed include: bladder, brain and central nervous system, colorectal, pancreatic, lung and pleura, leukemia, non-Hodgkin's lymphoma, stomach, kidney, female breast, and prostate. These cancer types were selected for review since State age-specific rates were available and published by the Cancer Registry. Males and females were evaluated separately. All races were combined for the analyses.

Analysis of the cancer incidence was completed using Standardized Incidence Ratios (SIRs). The SIR is calculated by dividing the observed number of cases by the expected number of cases. The expected number was mathematically derived by multiplying a comparison population's age-sex-specific incidence rates and the study area age-sex-specific population figures. Rates from two separate comparison populations were used to derive the expected number of cases: New Jersey average annual incidence rates (1986-1988) and the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program (1984-1988). The SEER data represents an approximately ten percent sample of the total U.S. population and provides a national average of cancer incidence rates. The study area age-sex-specific population was determined from the 1980 and 1990 U.S. Census Bureau data.

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.

Statistical significance in this investigation was evaluated using a 95 percent confidence interval (C.I.) (Breslow and Day, 1987). The 95% C.I. is used to evaluate the probability that the SIR may be greater than 1.0 due to chance alone. If the confidence interval includes 1.0, then the SIR is not considered to be significantly different than 1.0, using conventional definitions of "statistical significance".

At the request of local officials, the population in the three towns which was not included in the study area was combined and evaluated separately for all cancers combined and the eleven select cancer sites that were evaluated for the study area. In general, the population not included in the study area is more distant to the contamination than the study area population and, therefore, likely to be less exposed and affected. For the purposes of this report, this population grouping will be designated the non-study area. In all analyses, the referent group was either state or national cancer incidence rates.

## **RESULTS**

### **STUDY POPULATION**

The total population count in the selected census tracts for this investigation was 15,210 (8,005 females and 7,205 males). Table 1 presents the study area age-sex-specific population figures. The study population represents 39 percent of the total residents living in Maywood, Lodi, and Rochelle Park. Of the total, nearly 22 percent of the study population is under 20 years of age and approximately 16 percent is 65 or older, which is slightly older than the surrounding community with 25 percent and 12 percent respectively.

### **CANCER CASE ASCERTAINMENT**

For the ten year study period, the New Jersey Cancer Registry identified 2,248 newly diagnosed cases of cancer with either a Maywood, Lodi, or Rochelle Park municipal address. Of these cases, 886 (39.4%) were from study area census tracts, 1,321 (58.8%) were from census tracts outside the study area and 41 (1.8%) were not able to be located. The two main reasons for not identifying address location of these 41 cases were incomplete addresses and streets not locatable. Tables 2 and 3 present a description of the amount and types of cancer attributable to each of the three towns and the study area.

Table 4 presents the total study area cases by race, year of diagnosis, and age at diagnosis. Over 97 percent (862) of the cases were white and less than one percent of the cancers (6) occurred

in children (under 20 years of age). The number of cases diagnosed each year ranged from 76 to 117 with an average of nearly 89 per year.

A description of all the study area cases by sex and cancer type is presented in Table 5. Of the total 886 cases of cancer within the study area over the ten year study period, 52% (458) were among males and 48% (428) were among females. Among males, frequently occurring cancers were lung (101), prostate (75), colorectal (67) and bladder (44), representing nearly 63 percent of all cancers among males. For females, the most frequent study area cancers were breast (133), colorectal (75), lung (37), and uterine (23), representing nearly 63 percent of all cancers among females. These relative frequencies are similar to statewide cancer incidence figures.

## **SIR ANALYSIS**

Standardized Incidence Ratios (SIRs) were calculated for all cancers combined and 11 site specific cancer types. Table 6 presents the results of the SIR analysis by primary cancer type using average state cancer rates as the comparison. Only one of the SIRs, brain/central nervous system cancer (CNS) for females, was statistically elevated when compared to average state rates. The number of observed brain/CNS cancers for females (11) was double the expected number (5.4) with an SIR of 2.04 (95% C.I. = 1.02, 3.66). One of the SIRs, lung and pleura cancer for females, was statistically lower than state rates (SIR = 0.69; 95% C.I. = 0.49, 0.95). None of the cancer ratios for males were significantly different than expected.

Table 7 presents the SIR comparisons using SEER rates to calculate the expected number of cases for the study population. For males, all cancer sites combined, bladder cancer, and lung/pleura cancer were significantly elevated over the SEER rates. All cancers combined for males were 13 percent higher than expected (SIR = 1.13; 95% C.I. = 1.03, 1.24). Male bladder cancer was 55 percent higher than SEER rates (SIR = 1.55; 95% C.I. = 1.13, 2.08). Male lung/pleura cancer was 28 percent higher than SEER rates (SIR = 1.28; 95% C.I. = 1.04, 1.56). For females, lung cancer was statistically lower than SEER rates (SIR = 0.70; 95% C.I. = 0.49, 0.96). Although the SIR for brain/CNS cancer in females lost statistical significance using the SEER comparison rates, the magnitude of the effect remained nearly double the expected (SIR = 1.98; 95% C.I. = 0.99, 3.54).

As a regional comparison, SIRs were calculated for the non-study area population (the population outside the study area but still located within one of the three municipal boundaries) for all cancer sites combined and the same eleven site specific cancer types. Tables 8 and 9 present the non-study area SIR results. For females, all cancer sites combined and breast cancer were significantly elevated over the expected number of cases regardless of which comparison cancer rates were used, average state rates or SEER rates. Bladder cancer in males and colorectal cancer in females were also significantly elevated for the non-study area population when compared to SEER rates. No other non-study area SIR was significantly different than expected when compared to average state rates.

Table 10 presents an expanded description of the study and non-study area brain/CNS cases. The highest frequency of brain/CNS cases occurred in the older age groups for both study and non-

study area populations. The cases appear to be spread somewhat evenly through the study period with the exception of 1985 and 1986 which had the most number of study area cases (five and four, respectively). The most frequent type of brain/CNS cancer diagnosed in the study area was glioblastoma, with nine cases out of a total of 20. Only two of 17 non-study area cases were diagnosed with glioblastoma. However, nearly half of the non-study area brain/CNS cases were coded as malignant, not otherwise specified (NOS), compared with about one third of the study area cases. Glioblastoma generally represents about half of all histologically confirmed primary brain cancers in the U.S. (Schoenberg, 1982).

## **DISCUSSION**

Based on average state rates, the number of all newly diagnosed cancers in the population living closest to the contamination was not elevated compared to average state incidence rates. However, female brain and CNS cancers were significantly elevated and occurred twice as frequently as expected. Female lung and pleura cancers occurred significantly less often than expected for the study population. When SEER rates were used as the comparison for males, all cancers combined, bladder cancer, and lung cancer were found to be significantly elevated. Lung cancer in females continued to be significantly low, approximately 70 percent of expected, regardless of which comparison rates were used. Female brain/CNS cancer remained about twice the expected though no longer statistically significant. For females in the non-study area, all cancers combined and breast cancer were significantly higher compared to both state and SEER rates.

New Jersey state cancer incidence rates (all sites combined) are higher than SEER rates for both males and females. Male SEER adjusted rates are about six percent lower than state adjusted rates while female SEER adjusted rates are about seven percent lower than state adjusted rates (NCI, 1991). The state rates for specific cancer types may be higher or lower than SEER rates. The SEER rates are comprised of cancer incidence from a number of diverse state and local registries funded by the federal government. Those registries cover about ten percent of the U.S. population, both urban and rural locations, and their aggregation into a single set of rates is meant to approximate the average U.S. cancer incidence. New Jersey cancer incidence rates, on the other hand, reflect the cancer experience from a highly urbanized state and are similar to other northeastern, urbanized states with population registries.

The likelihood of developing cancer is the sum of numerous individual risks which include exposures to pollution in the environment, at work, lifestyle choices, and genetic susceptibility. In general, the use of state rates for calculating expected numbers can better control for the effect of occupation and life style, major influences on the risk of developing cancer, than SEER rates. The expected numbers generated using state rates, therefore, are more realistic for evaluating the impact of an environmental source than the SEER rates.

Of note, brain and central nervous system cancer in females was elevated in the study area. Nationally, the incidence of brain cancer has been increasing annually (SEER, 1993). Although little is known about the causes of brain cancer, studies have linked them with occupational,

environmental, viral, and genetic factors. Of interest, radiation exposure has been associated with increased incidence of brain cancer. Two studies (Modan, 1974; Shore, 1976) have found children undergoing radiation therapy for tinea capitis at elevated risk for both malignant and benign brain cancer. In a case-control study of women with benign brain cancer (Preston-Martin, 1978), researchers found a statistically significant association with medical and dental x-rays. Studies of prenatal x-ray exposure and subsequent brain tumors have provided conflicting results (MacMahon, 1962; Choi, 1970).

Experimental studies of industrial chemicals have identified over 30 compounds that result in a high incidence of nervous system cancers after systemic administration (Kleihues, 1978). Studies of occupational groups have also identified elevated risk of brain and CNS cancers with agricultural workers, oil and chemical workers, rubber manufacturing, and vinyl chloride exposure (Mancuso, 1963; Lamperth-Seiler, 1974; Waxweiler, 1976; Thomas and Waxweiler, 1986; Brownson, 1990).

Interpretation of these data should be done very cautiously. Although female brain/CNS cancer was elevated in the study area, the methodology employed only provides a description of the level of cancer in the area, while cause-effect relationships cannot be assessed. As more statistical comparisons are made, the number of spurious results (elevated or depressed by chance alone) increases. In this study 88 statistical comparisons have been made and twelve SIRs found to be statistically significant (ten elevated and two depressed).

Additionally, a serious limitation of cancer studies of this type is the inability to assess past exposure levels to 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 what was the magnitude of the exposure that did occur. Since personal exposure information does not exist, residential distance from the contaminated sites was used as a surrogate measure for potential past exposure. This was accomplished by grouping the population living in the selected nearby census tracts into a potentially exposed study area. Although distance from the sites may have been the best way to estimate past potential exposures at the time the study was designed, it is also likely that not all of the residents in this area were exposed to the contamination due to the study area size. 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, but no information is available on length of time an individual may have lived at the address before diagnosis. It is likely that some cases 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 will offset each other. If this assumption is incorrect, the effect of migration is likely to bias the results toward the null hypothesis of no effect.

In conclusion, total cancer incidence and all but one of the specific cancer type analyses for the study area were not significantly different than expected when compared to average state incidence rates. The notable exception was female brain/CNS cancer which experienced a two-fold increase in the female study population. The non-study area female population had a brain/CNS cancer incidence similar to average state rates. However, the reason for this increase in the study area is unknown at this time. Little information is available on the cases beyond residence at time of diagnoses. Information on other potential risk factors for the cases could not be evaluated for this review.

## **RECOMMENDATIONS**

1. Because of the relatively small number of brain/CNS cases included in this analysis, it is not possible to conduct studies to determine potential causes of this case series. Larger epidemiologic studies are needed, especially directed on a national scale, to better elucidate the risk factors for brain/CNS cancer, so that effective preventive measures can be developed.
2. Given the elevation of brain/CNS cancer in the study area, the Department of Health and Senior Services plans to continue surveillance of brain cancer in the study area. The Department has prepared an Addendum to this document containing an analysis of data through 1995. Future updates will be prepared periodically, as sufficient new information on cancer incidence becomes available.
3. We further recommend that ATSDR review this information in relation to other comparable data available for similar sites in the country in an effort to find consistency of effect. Consequently, New Jersey statewide data have been added to a multistate federal study of brain cancer in relation to residence near hazardous waste sites.



## REFERENCES

- Agency for Toxic Substances and Disease Registry: Health Assessment for Maywood Chemical Company. Trenton, New Jersey, 1990.
- Agency for Toxic Substances and Disease Registry: Site Review and Update for the Maywood Chemical Company, Maywood/Rochelle Park, Bergen County, New Jersey. Atlanta, Georgia, 1992.
- Breslow, N.E. and Day, N.E.: Statistical Methods in Cancer Research: Vol II-The Design and Analysis of Cohort Studies, E. Heseltine, ed. IARC Scientific Publication No. 82, International Agency for Research on Cancer, Lyon, 1987.
- Brownson, R.C., Reif, J.S., Chang, J.C., and Davis, J.R.: An Analysis of Occupational Risks for Brain Cancer. *AJPH* 80:169-172, 1990.
- Choi, N.W., Schuman, L.M., and Gullen, W.H.: Epidemiology of Primary Central Nervous System Neoplasms: II. Case-control Study. *Am J Epidemiol* 91:467-485, 1970.
- Kleihues, P.: Chemical Carcinogenesis in the Nervous System. In *Biology of Brain Tumors*. Laerium, Bigner, and Rajewsky, eds. Geneva, 1978.
- Lanperth-Seiler, E.: Harweg- und Hirntumoren bei Gummiarbeitern. *Schweiz Med Wochenschr* 104:1655-1659, 1974.
- MacMahon, B.: Prenatal x-ray Exposure and Childhood Cancer. *JNCI* 28:1173-1191, 1962.
- Mancuso, T.F.: Tumors of the Central Nervous System: Industrial Considerations. *Acta Unio Internat Contra Cancrum* 19:488-489, 1963.
- Moden, B., Baidatz, D., Mart, H., et al: Radiation Induced Head and Neck Tumors. *Lancet* 1:277-279, 1974.
- National Cancer Institute: Cancer Incidence and Mortality in the United States (SEER), 1984-1988. Bethesda, Maryland, 1991.
- National Cancer Institute: SEER Cancer Statistics Review, 1973-1990. Bethesda, Maryland, 1993.
- Preston-Martin, S.: A Case-control Study of Intracranial Meningiomas in Women. *Am J Epidemiol* 108:233-234, 1978.
- Schoenberg, B.S.: Nervous System. In *Cancer Epidemiology and Prevention*, Schoenberg and Fraumeni, eds. W.B. Saunders Co., 1982.

Shore, R.E., Albert, R.E., and Pasternack, B.S.: Follow-up Study of Patients Treated by x-ray Epilation for Tinea Capitus: Resurvey of Post-treatment Illness and Mortality Experience. Arch Environ Health 31:21-28, 1976.

Thomas, T.L. and Waxweiler, R.J.: Brain Tumors and Occupational Risk Factors. Scand J Environ Health 12:1-15, 1986.

Waxweiler, R.J., Stringer, W., Wagoner, J.K., et al: Neoplastic Risk Among Workers Exposed to vinyl Chloride. Ann NY Acad Sci 271:40-48, 1976.

United States Census Bureau: Population Census Report, General Population Characteristics, 1980.

United States Census Bureau: Population Census Report, General Population Characteristics, 1990.

United States Department of Energy: Health and Safety Plan for the Remedial Investigation/ Feasibility Study-Environmental Impact Statement for the Maywood Site, Maywood, New Jersey. Oak Ridge, Tennessee, 1990.

United States Environmental Protection Agency: Record of Decision for the Lodi Municipal Well Site, 1993.

**TABLES**

Table 2

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Cancer Incidence in Lodi, Maywood, and Rochelle Park  
 1979 - 1988

Cancer Type	Lodi	Maywood	Rochelle Park
Bladder	70	35	21
Bone and Joint	4	0	1
Brain/Central Nervous System	13	19	5
Breast	205	99	59
Cervix	46	9	10
Colorectal	183	115	71
Corpus uteri	34	15	10
Endocrine	18	4	2
Esophagus	8	10	5
Eye	1	0	1
Gallbladder	13	6	3
Hodgkin's Disease	11	4	3
Kidney	24	14	11
Larynx	12	9	5
Leukemia	36	18	9
Liver	7	2	2
Lung/pleura	195	93	61
Myeloma	10	6	3
Oralpharynx	27	8	7
Other Digestive	1	2	1
Other Respiratory	3	1	0
Other Female Genital	15	3	2
Other Male Genital	1	0	1
Ovary	29	11	6
Non-Hodgkin's Lymphoma (NHL)	45	16	10
Pancreas	25	11	8
Prostate	87	69	35
Skin	23	20	11
Small Intestine	5	1	3
Soft Tissue	5	1	0
Stomach	34	8	8
Testis	5	1	1
Other or Unknown primary	35	28	5
Total:	1,230	638	380

Table 3

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Cancer Incidence by Study Area Location  
 1979 - 1988

Cancer Type	Cases		
	In	Out	Unknown
Bladder	52	73	1
Bone and Joint	1	3	1
Brain/Central Nervous System	20	17	0
Breast	135	224	4
Cervix	21	41	3
Colorectal	142	221	6
Corpus uteri	23	35	1
Endocrine	9	15	0
Esophagus	11	12	0
Eye	2	0	0
Gallbladder	6	15	1
Hodgkin's Disease	4	14	0
Kidney	20	29	0
Larynx	12	12	2
Leukemia	26	35	2
Liver	6	5	0
Lung/pleura	138	205	6
Myeloma	10	9	0
Oralpharynx	17	25	0
Other Digestive	1	3	0
Other Respiratory	2	2	0
Other Female Genital	7	13	0
Other Male Genital	1	1	0
Ovary	14	29	3
Non-Hodgkin's Lymphoma (NHL)	32	39	0
Pancreas	20	23	1
Prostate	75	114	2
Skin	26	27	1
Small Intestine	4	5	0
Soft Tissue	3	3	0
Stomach	17	30	3
Testis	4	3	0
Other or Unknown primary	25	39	4
Total:	886	1,321	41

Table 4

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Age, Race, Year of Diagnosis and Sex of Cases in Study Area  
 1979 - 1988

CHARACTERISTIC		Cases		
		Male	Female	Total
Race:	White	447	415	862
	Non-White	11	13	24
Total:		458	428	886
Age Group:	0 - 4	0	0	0
	5 - 9	2	0	2
	10 - 14	0	0	0
	15 - 19	0	4	4
	20 - 24	3	0	3
	25 - 29	6	11	17
	30 - 34	3	6	9
	35 - 44	17	20	37
	45 - 54	27	41	68
	55 - 59	42	57	99
	60 - 64	56	55	111
	65 - 74	158	116	274
75 - 84	114	91	205	
85+	30	27	57	
Total:		458	428	886
Year of Diagnosis:	1979	43	38	81
	1980	59	34	93
	1981	41	40	81
	1982	38	38	76
	1983	44	42	86
	1984	40	37	77
	1985	63	51	114
	1986	43	46	89
	1987	44	55	99
	1988	43	47	90
	Total:		458	428

Table 5

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Cancer Incidence Within Study Area  
 1979 - 1988

Cancer Type	Cases		
	Male	Female	Total
Bladder	44	8	52
Bone and Joint	1	0	1
Brain/Central Nervous System	9	11	20
Breast	2	133	135
Cervix	-	21	21
Colorectal	67	75	142
Corpus uteri	-	23	23
Endocrine	3	6	9
Esophagus	8	3	11
Eye	0	2	2
Gallbladder	1	5	6
Hodgkin's Disease	3	1	4
Kidney	17	3	20
Larynx	10	2	12
Leukemia	15	11	26
Liver	4	2	6
Lung/pleura	101	37	138
Myeloma	5	5	10
Oralpharynx	13	4	17
Other Digestive	0	1	1
Other Respiratory	1	1	2
Other Female Genital	-	7	7
Other Male Genital	1	-	1
Ovary	-	14	14
Non-Hodgkin's Lymphoma (NHL)	20	12	32
Pancreas	11	9	20
Prostate	75	-	75
Skin	19	7	26
Small Intestine	2	2	4
Soft Tissue	3	0	3
Stomach	9	8	17
Testis	4	-	4
Other or Unknown primary	10	15	25
Total:	458	428	886

Table 6

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Standardized Incidence Ratios (SIR) for Study Area  
 Comparison of Observed and Expected Cancer Incidence  
 Using Average Annual State Rates, 1986-1988  
 1979 - 1988

Cancer Type	Sex	-----Cases-----		SIR	95% C.I. . Lower-Upper
		Observed	Expected		
All Cancers:	Male	458	433.0	1.06	0.96 - 1.16
	Female	428	466.7	0.92	0.83 - 1.01
Bladder:	Male	44	35.2	1.25	0.91 - 1.68
	Female	8	13.3	0.60	0.26 - 1.19
Brain/CNS:	Male	9	6.1	1.49	0.68 - 2.82
	Female	11	5.4	2.04 *	1.02 - 3.66
Breast:	Female	133	136.9	0.97	0.81 - 1.15
Colorectal:	Male	67	72.4	0.93	0.72 - 1.18
	Female	75	76.5	0.98	0.78 - 1.24
Kidney:	Male	17	12.4	1.37	0.80 - 2.19
	Female	3	8.7	0.34	0.07 - 1.00
Leukemia:	Male	15	11.5	1.31	0.73 - 2.15
	Female	11	9.9	1.12	0.56 - 2.00
Lung/pleura:	Male	101	87.9	1.15	0.94 - 1.40
	Female	37	53.6	0.69 **	0.49 - 0.95
NHL:	Male	20	14.4	1.39	0.85 - 2.15
	Female	12	14.8	0.81	0.42 - 1.41
Pancreas:	Male	11	11.3	0.97	0.48 - 1.74
	Female	9	13.3	0.68	0.31 - 1.28
Prostate:	Male	75	83.5	0.90	0.71 - 1.13
Stomach:	Male	9	12.8	0.71	0.32 - 1.34
	Female	8	10.1	0.80	0.34 - 1.57

\* Statistically elevated at the  $p < 0.05$  level.

\*\* Statistically low at the  $p < 0.05$  level.



Table 7

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Standardized Incidence Ratios (SIR) for Study Area  
 Comparison of Observed and Expected Cancer Incidence  
 Using SEER Average Annual Rates, 1984-1988  
 1979 - 1988

Cancer Type	Sex	-----Cases-----		SIR	95% C.I.	
		Observed	Expected		Lower	Upper
All Cancers:	Male	458	406.0	1.13 *	1.03	1.24
	Female	428	431.3	0.99	0.90	1.09
Bladder:	Male	44	28.4	1.55 *	1.13	2.08
	Female	8	11.1	0.72	0.31	1.42
Brain/CNS:	Male	9	5.8	1.55	0.71	2.94
	Female	11	5.6	1.98	0.99	3.54
Breast:	Female	133	127.7	1.04	0.87	1.23
Colorectal:	Male	67	58.4	1.15	0.89	1.46
	Female	75	66.1	1.13	0.89	1.42
Kidney:	Male	17	10.3	1.65	0.96	2.65
	Female	3	7.0	0.43	0.09	1.26
Leukemia:	Male	15	11.6	1.29	0.72	2.13
	Female	11	9.9	1.12	0.56	2.00
Lung/pleura:	Male	101	78.8	1.28 *	1.04	1.56
	Female	37	53.1	0.70 **	0.49	0.96
NHL:	Male	20	14.3	1.40	0.85	2.16
	Female	12	14.4	0.83	0.43	1.45
Pancreas:	Male	11	10.5	1.05	0.52	1.87
	Female	9	12.4	0.72	0.33	1.37
Prostate:	Male	75	91.3	0.82	0.65	1.03
Stomach:	Male	9	11.4	0.79	0.36	1.49
	Female	8	8.1	0.99	0.43	1.95

\* Statistically elevated at the  $p < 0.05$  level.

\*\* Statistically low at the  $p < 0.05$  level.

Table 8

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Standardized Incidence Ratios (SIR) for Non-Study Area  
 Comparison of Observed and Expected Cancer Incidence  
 Using Average Annual State Rates, 1986-1988  
 1979 - 1988

Cancer Type	Sex	-----Cases-----		SIR	95% C.I.	
		Observed	Expected		Lower	Upper
All Cancers:	Male	611	606.2	1.01	0.93	1.09
	Female	714	638.9	1.12 *	1.04	1.20
Bladder:	Male	53	48.7	1.09	0.81	1.42
	Female	20	17.5	1.14	0.70	1.77
Brain/CNS:	Male	9	8.9	1.01	0.46	1.91
	Female	8	7.8	1.03	0.44	2.02
Breast:	Female	225	192.1	1.17 *	1.02	1.33
Colorectal:	Male	110	100.2	1.10	0.90	1.32
	Female	111	98.7	1.12	0.92	1.35
Kidney:	Male	18	17.7	1.02	0.60	1.61
	Female	11	12.0	0.92	0.46	1.64
Leukemia:	Male	14	16.2	0.86	0.47	1.45
	Female	21	13.3	1.58	0.98	2.42
Lung/pleura:	Male	131	124.2	1.05	0.98	1.25
	Female	76	74.0	1.03	0.81	1.28
NHL:	Male	16	20.4	0.78	0.45	1.27
	Female	23	20.0	1.15	0.73	1.73
Pancreas:	Male	13	15.8	0.82	0.44	1.41
	Female	10	17.4	0.58	0.28	1.06
Prostate:	Male	114	113.2	1.01	0.83	1.21
Stomach:	Male	14	17.8	0.79	0.43	1.32
	Female	16	12.8	1.25	0.71	2.03

\* Statistically elevated at the  $p < 0.05$  level.

\*\* Statistically low at the  $p < 0.05$  level.

Table 9

Njdhss, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Standardized Incidence Ratios (Sir) for Non-Study Area  
 Comparison of Observed and Expected Cancer Incidence  
 Using SEER Average Annual Rates, 1984-1988  
 1979 - 1988

Cancer Type	Sex	-----Cases-----		SIR	95% C.I.	
		Observed	Expected		Lower	Upper
All Cancers:	Male	611	569.6	1.07	0.99	1.16
	Female	714	592.8	1.20 *	1.12	1.30
Bladder:	Male	53	39.4	1.35 *	1.01	1.76
	Female	20	14.5	1.38	0.84	2.13
Brain/CNS:	Male	9	8.6	1.04	0.48	1.98
	Female	8	7.9	1.01	0.44	1.99
Breast:	Female	225	179.3	1.26 *	1.10	1.43
Colorectal:	Male	110	124.8	0.88	0.72	1.06
	Female	111	84.4	1.32 *	1.08	1.58
Kidney:	Male	18	14.7	1.23	0.73	1.94
	Female	11	9.6	1.15	0.57	2.06
Leukemia:	Male	14	16.3	0.86	0.47	1.44
	Female	21	13.3	1.58	0.98	2.42
Lung/pleura:	Male	131	111.9	1.17	0.98	1.39
	Female	76	66.1	1.15	0.91	1.44
NHL:	Male	16	20.4	0.78	0.45	1.27
	Female	23	19.6	1.18	0.75	1.76
Pancreas:	Male	13	14.6	0.89	0.47	1.53
	Female	10	16.2	0.62	0.30	1.14
Prostate:	Male	114	124.8	0.91	0.75	1.10
Stomach:	Male	14	15.9	0.88	0.48	1.48
	Female	16	10.4	1.54	0.88	2.49

\* Statistically elevated at the  $p < 0.05$  level.

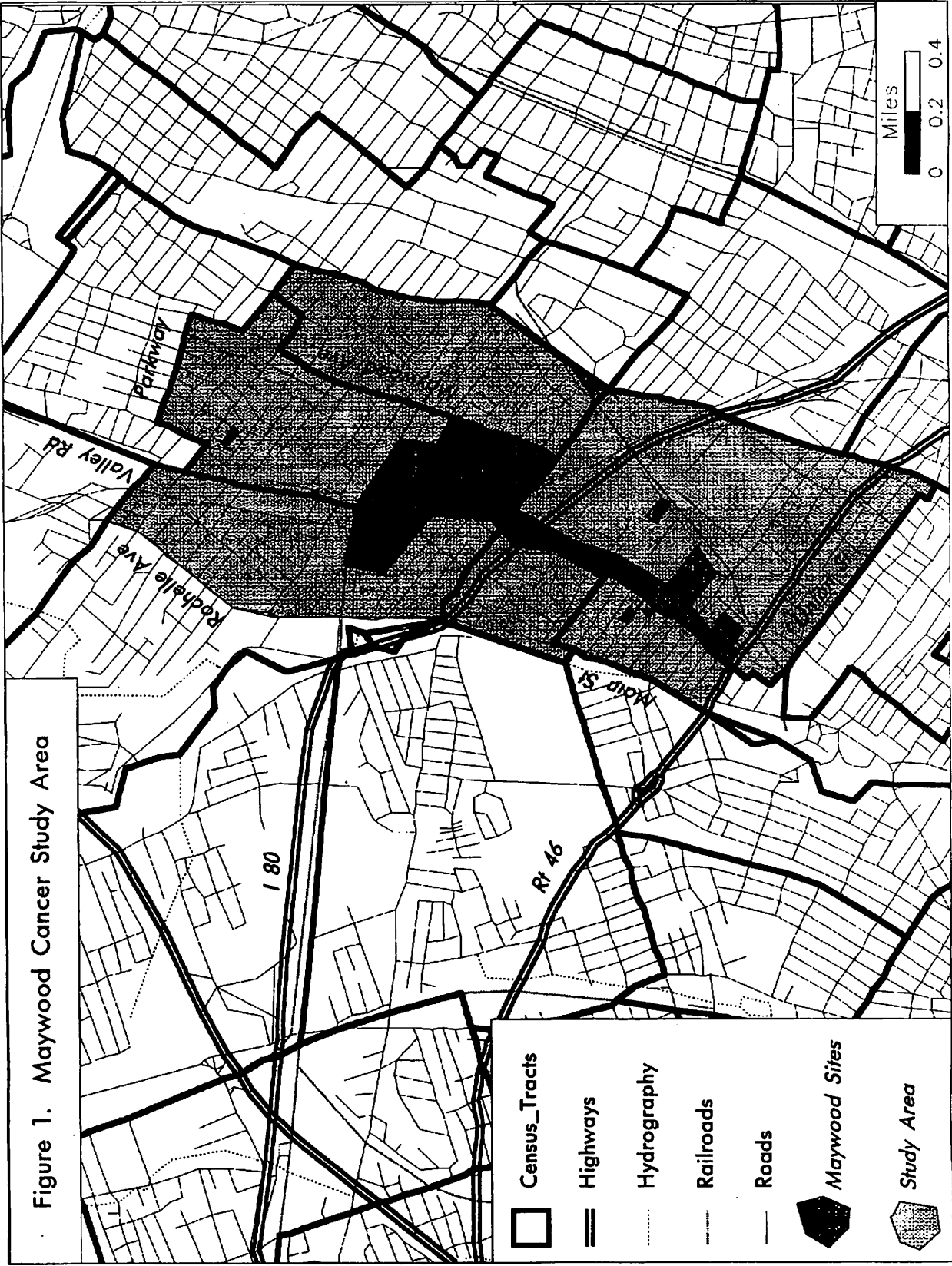
\*\* Statistically low at the  $p < 0.05$  level.

Table 10

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study  
 Age, Year of Diagnosis, and Type of Brain/CNS Cancer by Sex  
 1979 - 1988

CHARACTERISTIC	-----Study Area-----		-----Non-Study Area-----	
	Male	Female	Male	Female
Age Group:				
0 - 19	0	2	0	2
20 - 44	2	0	1	1
45 - 64	4	1	3	2
65 - 74	3	1	5	0
75+	0	7	0	3
Total:	9	11	9	8
Year of Diagnosis:				
1979	0	0	1	1
1980	1	0	0	0
1981	0	1	2	1
1982	1	0	1	2
1983	0	2	0	0
1984	1	2	0	1
1985	5	0	0	0
1986	0	4	2	2
1987	1	2	2	0
1988	0	0	1	1
Total:	9	11	9	8
Brain/CNS Cancer Type:				
Malignant, NOS	3	3	3	5
Glioma	1	0	1	1
Ependymoma	1	0	2	0
Astrocytoma	0	2	2	1
Spongioblastoma	1	0	0	0
Glioblastoma	3	6	1	1
Total:	9	11	9	8

**FIGURE**



**APPENDIX**

**ADDENDUM**  
**Malignant Brain and Central nervous System Cancer**  
**1979 - 1995**

The New Jersey Department of Health and Senior Services (NJDHSS) recently completed a study evaluating cancer incidence in residents of Maywood, Lodi, and Rochelle Park. The study, *Cancer Incidence in Three Communities Near the Maywood Area Superfund Sites*, examined ten years of cancer data (1979-1988) from the New Jersey State Cancer Registry (SCR) in order to assess the potential cancer impact due to the radiological and chemical contamination from the sites. The objective of the study was to evaluate whether the population residing closest to the contaminated areas had elevated cancer incidence.

The results of the study indicated that brain and central nervous system (CNS) cancer in females was twice as high as would be expected. Although very little is known about the causes of brain cancer, studies have identified radiation as a risk factor. Given the elevation of brain cancer in the study area, the NJDHSS recommended continued surveillance of brain cancer in the area and committed to provide an update of additional years of data by the Summer of 1997. This Addendum summarizes the update and reanalysis of brain and central nervous system cancer in the original study area for 1979 through 1995.

As with the original study, standardized incidence ratios (SIR) were computed for malignant brain/CNS cancer incidence by sex for the study area (see Figure 1). The SIR was calculated by dividing the observed number of cases by the expected number. The observed number was determined from information in the SCR for the three towns. The expected number of cases was based on the estimate of the study population (using U.S. Census Bureau data) and average New Jersey State cancer incidence rates (1986-1988).

Evaluation of the observed and expected numbers was accomplished by interpreting the ratio (SIR) 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, more cases than expected were observed.

Random fluctuations may account for some SIR deviations from 1.0. The statistical significance of deviations from SIR=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. If the 95% confidence interval includes 1.0, then the SIR was not considered to be significantly different from 1.0.

Brain/CNS cancer was evaluated for the study area for the time period January 1, 1979 through December 31, 1995, all complete years of information in the Registry. Additionally, to see whether the incidence has changed over the study period, brain/CNS cancer was evaluated in two distinct periods: 1979 through 1988 (the original study period) and 1989 through 1995.



Table 1 presents a description of the cases by age group, year of diagnosis, and histological type of brain/CNS. A total of 12 males and 17 females were diagnosed with brain/CNS cancer over the 17-year study period.

Table 2 presents the results of the SIR analysis. The number of observed brain/CNS cancer in males was similar to the expected for the entire 17-year study period. During the entire 17-year period, brain/CNS in females was statistically significantly elevated (SIR = 1.86; 95% CI = 1.08, 2.97) similar to the SIR found in the original 10-year study period (SIR = 2.04; 95% CI = 1.02, 3.66). In the 1989 through 1995 period, brain/CNS cancer incidence in females was elevated but not significantly (6 observed vs. 3.8 expected). Over the 17-year period (Table 3), the excess incidence of brain/CNS cancer in females occurred in the 75+ age group (SIR = 4.50; 95% CI = 1.94, 8.87).

It is important to note that the SCR provided information on two additional females in the study area diagnosed with brain/CNS cancer in 1996. Although these data were not included in this analysis since complete Registry information for 1996 was not available, inclusion of this data would have increased the female brain/CNS cancer ratio in the later time period to near the ratio in the earlier period.

Because the number of brain cancers is relatively small, epidemiological studies to evaluate potential etiological factors in this case series would not be productive. Larger epidemiological studies are needed, especially directed on a national scale, to better elucidate the risk factors for brain cancer. Consequent to this cancer study, New Jersey statewide data has been added to a multistate federal study of brain cancer in relation to residence near hazardous waste sites.

Given the continued elevation of brain/CNS cancer for females in the study area, NJDHSS will continue its surveillance for this area and provide periodic updates as additional years of Registry information become available.

Table 1

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study Addendum  
 Age, Year of Diagnosis, and Type of Malignant Brain/CNS by Sex  
 1979 - 1995

Characteristic	-----Study Area-----	
	Male	Female
Age Group:		
0 - 19	0	2
20 - 44	3	0
45 - 64	5	5
65 - 74	3	2
75+	<u>1</u>	<u>8</u>
Total:	12	17
Year of Diagnosis:		
1979	0	0
1980	1	0
1981	0	1
1982	1	0
1983	0	2
1984	1	2
1985	5	0
1986	0	4
1987	1	2
1988	0	0
1989	0	2
1990	1	0
1991	0	1
1992	0	1
1993	1	0
1994	1	0
1995	0	2
Brain/CNS Cancer Type:		
Malignant, NOS	3	4
Glioma	1	0
Ependymoma	1	0
Astrocytoma	1	2
Spongioblastoma	1	0
Glioblastoma	5	11

Table 2

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study Addendum  
 Standardized Incidence Ratios (SIR) for Study Area  
 Comparison of Observed and Expected Numbers  
 Malignant Brain/CNS Cancer Incidence  
 1979 - 1995

Time Period	Sex	-----Cases-----		SIR	95% C.I. Lower - Upper
		Observed	Expected		
1979 - 1995	Male	12	10.3	1.16	0.60 - 2.03
	Female	17	9.2	1.86 *	1.08 - 2.97
1979 - 1988	Female	11	5.4	2.04 *	1.02 - 3.66
1989 - 1995	Female	6	3.8	1.59	0.58 - 3.47

\* Statistically elevated at the  $p < 0.05$  level.

Table 3

NJDHSS, Consumer and Environmental Health Services  
 Maywood Cancer Study Addendum  
 Standardized Incidence Ratios (SIR) by Age Group  
 For Brain/CNS Cancer Incidence in Study Area Females  
 1979 - 1995

Age Group	-----Cases-----		SIR	95% C.I. Lower - Upper
	Observed	Expected		
0 - 19	2	0.6	3.14	0.35 - 11.34
20 - 44	0	1.2	0	
45 - 64	5	2.9	1.73	0.39 - 2.84
65 - 74	2	2.6	0.76	0.09 - 2.75
75+	8	1.8	4.50 *	1.94 - 8.87

\* Statistically elevated at the  $p < 0.05$  level.