Health Consultation

Follow-up Review of Bladder Cancer

RAYMARK INDUSTRIES
(a/k/a RAYMARK INDUSTRIES, INCORPORATED)

STRATFORD, FAIRFIELD COUNTY, CONNECTICUT

EPA FACILITY ID: CTD001186618

Prepared by the
Connecticut Department of Public Health

OCTOBER 27, 2011

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

Health Consultation: A Note of Explanation

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SUMMARY

INTRODUCTION

This Health Consultation was prepared by the Connecticut Department of Public Health (CTDPH) to satisfy recommendations contained in its 2001 Health Consultation entitled Review of Bladder Cancer Data for Stratford, CT. In the 2001 report, it was recommended that when at least five more years of bladder cancer data become available, male and female bladder cancer should be reviewed to evaluate whether the apparent increasing trend in male bladder cancer in Stratford persisted over time. The recommendation also stated that bladder cancer data trends over time in towns around Stratford be evaluated. Bladder cancer has been the focus of several health studies in Stratford because a CTDPH cancer review in the early 1990s indicated elevated bladder cancer rates in Stratford, as compared with the state of Connecticut. Solvent exposure is one risk factor for bladder cancer and solvents were used and disposed at the Raymark Industries Facility.

CONCLUSIONS

CTDPH reached the following 4 conclusions in the health consultation.

Conclusion 1

Over the 42 years of data evaluated in this study, there is no increasing or decreasing trend for male or female bladder cancer in Stratford. Additionally, bladder cancer trends over time in the three geographic comparison areas are similar to Stratford.

Basis for conclusion

CTDPH evaluated an additional 11 years of bladder cancer data (1997-2007) since the previous CTDPH health study was conducted in 2001. A linear regression analysis on the cancer incidence rates over the entire 42 year period (1965-2007) was performed. Linear regression is a statistical technique used to identify a relationship between a "target" variable and other variables. In this case, the target variable was bladder cancer and the other variable was time interval for year of cancer diagnosis. The results showed no correlations (links) between the bladder cancer incidence rate in Stratford and time, regardless of which of the three geographic comparison areas is used (state of Connecticut, 15 towns with similar population as Stratford, 5 towns bordering Stratford).

Next Steps

CTDPH will work with the Stratford Health Department to communicate this study finding to the local community.

Conclusion 2	During the additional 11 years (1997-2007) evaluated in this new review, bladder cancer incidence rates in Stratford are not elevated (with statistical significance) above cancer rates in any of the three geographic comparison areas.
Basis for conclusion	To examine whether bladder cancer rates in Stratford differ from expected rates, CTDPH calculated Standardized Incidence Ratios (SIRs) for Stratford as compared with three geographic comparison areas (state of Connecticut, 15 towns with similar population as Stratford, 5 towns bordering Stratford). For both males and females, Stratford bladder cancer rates are not different (with statistical significance) from the three geographic comparison areas.
Next Steps	CTDPH will work with the Stratford Health Department to communicate this study finding to the local community.

Conclusion 3	During the 1985-1989 time interval, male and female bladder cancer incidence rates in Stratford were higher than expected, as compared to the geographic comparison areas. During the 1995-1999 time interval, bladder cancer incidence rates in Stratford females were lower than expected, as compared to the geographic comparison areas. While these differences are not large, they are statistically significant. These are not new findings; these differences were observed in earlier CTDPH cancer studies.
Basis for conclusion	To examine whether bladder cancer rates in Stratford differ from expected rates during any of the time intervals, CTDPH calculated Standardized Incidence Ratios (SIRs) for Stratford as compared with three geographic comparison areas (state of Connecticut, 15 towns with similar population as Stratford, 5 towns bordering Stratford). For males and females, SIRs in Stratford were higher than expected (with statistical significance) during the 1985-1989 time interval. The highest SIR was 1.57 (for males), meaning that that Stratford males had a 57% higher bladder cancer rate than the comparison location. During the 1995-1999 time interval, bladder cancer in Stratford females was lower than expected (with statistical significance). The lowest SIR was 0.59, meaning a 41% lower bladder cancer incidence rate in Stratford than in the comparison location.
Next Steps	CTDPH will work with the Stratford Health Department to ensure that the local community understands this information.

Conclusion 4	It is not possible to determine the cause of the statistically significant differences in bladder cancer in Stratford, as compared with the three geographic comparison locations.
Basis for conclusion	The evaluations conducted in this review examined bladder cancer incidence in Stratford as compared with three geographic comparison areas. It was not designed to examine causal relationships for cancer. There are many factors such as smoking, family history, and occupational exposure to bladder carcinogens that could not be accounted for in this analysis. These factors might have been causes or contributing factors to cancer increases or decreases. It is also possible that the cancer rate differences are due to chance or random variation. Finally, it cannot be ruled out that exposure to Raymark waste caused or contributed to the increase in bladder cancer in Stratford during the 1985-1989 time interval. However, this is an unlikely cause because previous CTDPH studies of cancer in Stratford evaluated patterns of cancer cases in Stratford relative to known locations of Raymark waste and concluded that there were no statistically significant increases in male or female bladder cancer as one moved closer to known Raymark waste sites.
Next Steps	CTDPH will work with the Stratford Health Department to ensure that the local community understands this information.

FOR MORE INFORMATION	If you have questions about material presented in this health consultation, you should contact the CT Department of Public Health at 860-509-7740.

1. BACKGROUND AND STATEMENT OF ISSUE

The Raymark facility, formerly known as Raybestos-Manhattan Incorporated, was originally an automotive components manufacturing plant occupying approximately 33 acres that specialized in the production of gaskets, clutches, and heavy brake friction components. During Raymark's long industrial history in Stratford, CT, it generated many different hazardous wastes. Among the byproducts of the manufacturing process were asbestos, lead, polychlorinated biphenyls (PCBs), copper, solvents, adhesives, resins, and various other chemicals. From 1919 to 1984, Raymark used a system of lagoons in an attempt to capture the waste products. Over this 65-year period, these lagoon systems were located throughout the western and central portions of the Raymark site. As the lagoons filled up with sludge, they were often dredged and the material was used as fill in locations around Stratford. At several locations, the fill was evident in surface soil by the presence of brake parts and friable asbestos. Locations receiving contaminated Raymark waste fill included residences, businesses, a creek, beach areas, a school, and a park.

Throughout its long operating history, the Raymark facility was also the source of chemical releases to the ambient air. Manufacturing operations likely resulted in releases of airborne asbestos, metals, and solvents to the air.

Solvents present in Raymark waste products in the lagoons also leached into the groundwater, ultimately contaminating the groundwater in an area approximately 500 acres in size, around the former Raymark facility. A densely developed residential neighborhood exists above a portion of the groundwater solvent plume.

The Agency for Toxic Substances and Disease Registry (ATSDR) issued a Public Health Advisory in 1993. Afterward, the Environmental Protection Agency (EPA), ATSDR, the Connecticut Department of Environmental Protection (DEP), the Connecticut Department of Public Health (CTDPH), and the Stratford Health Department initiated a number of activities to identify additional waste areas, reduce or eliminate exposure to known sites, and address public health questions. These activities included extensive surface and subsurface soil sampling, groundwater sampling, indoor air sampling, review of environmental data, assessment of human exposures and associated health impacts, voluntary blood lead screening, posting and other

access restrictions, temporary capping of contaminated soils, soil removals, installation of subslab ventilation systems in residential basements, and reviews of health outcome data. A comprehensive public health assessment was completed for Raymark in September 1996 (ATSDR 1996) and provides details on the history of the site, as well as pathways of exposure. A major health consultation evaluating exposure to solvents in groundwater via the vapor intrusion exposure pathway was completed in 2003 (ATSDR 2003).

Several health studies have been performed that focus on the incidence of various cancers, birth weight, and birth defects. These health studies are summarized below.

1a. Previous Health Studies

A preliminary review of cancer in Stratford was published by CTDPH in 1993 (ATSDR 1993). This study looked at rates for a large number of cancers in Stratford over the years 1958-1991. The study found that although the overall incidence of cancer in Stratford was not elevated during the time period evaluated, there were some differences in Stratford rates versus the State of Connecticut rates for three cancer types (bladder, mesothelioma and cancer in people less than 25 years of age). Rates for all three of these cancer types were higher in Stratford than the state as a whole.

In 1998, CTDPH published a follow-up study that further explored the cancer types that were elevated in the 1993 review (ATSDR 1998). The 1998 study also reviewed the scientific literature regarding environmental risk factors associated with each of the cancers evaluated in the study. The scientific literature indicates that cigarette smoking is the greatest risk factor for bladder cancer. Smokers are more than twice as likely to get bladder cancer as nonsmokers (American Cancer Society 2011). Published studies also indicate that bladder cancer has been shown to be elevated among certain occupational groups including those who manufacture or work with dyes (particularly benzidine), aromatic amines, leather, rubber, and aluminum. Painters, dry cleaners, truck drivers and those who work with organic chemicals have also experienced a higher risk of bladder cancer. Studies of cancer clusters have suggested links between exposure to chlorinated solvents in drinking water and bladder cancer. Drinking water containing disinfectant by-products has also been associated with an increased risk of bladder

cancer in some studies (ATSDR 1998). Unlike the 1993 cancer review, the 1998 follow-up study used a model to estimate exposure to Raymark contaminants based on geographic proximity to known locations of Raymark waste. Time trends in cancer incidence were also evaluated. The 1998 study found that there appeared to be an increasing trend in incidence of bladder cancer over time for males in Stratford. However, the trend appeared to be town-wide and not associated with geographic proximity to Raymark waste. The other finding was a statistically significant elevation in bladder cancer among women who lived closer to Raymark waste. However, as discussed in the following paragraph, this finding was not replicated in the 2001 follow-up evaluation, which used a more refined exposure methodology.

In 2001, CTDPH re-analyzed bladder cancer data from the 1998 study using improved methodologies to more accurately evaluate exposure by means of geographic proximity to Raymark waste and to analyze patterns of bladder cancer in Stratford over time. Also, an additional five years of bladder cancer data were added to the analysis (1992-1996). The improved analysis showed that there appeared to be a slight elevation in bladder cancer in females who lived closer to Raymark waste, however; the elevation was not present consistently over the entire study period and there was no evidence of an increase in the trend over time of female bladder cancer in Stratford. For males, the study found evidence of an increase in the trend over time of male bladder cancer in Stratford. The study also supported the 1998 finding of no apparent association between bladder cancer and geographic proximity to Raymark waste. The 2001 study recommended that a final follow-up of bladder cancer in males and females be conducted when at least 5 years of additional cancer data were available. The 2001 study also recommended an evaluation of bladder cancer in towns around Stratford to determine if increasing bladder cancer time trends exist in areas other than Stratford.

1b. Purpose

The purpose of the current study is two-fold:

(1) Conduct a follow-up evaluation of the time trend for bladder cancer in Stratford, with 11 additional years of bladder cancer data that are available; and

(2) Evaluate bladder cancer time trends in towns around Stratford, to determine whether trends in other areas look similar to Stratford.

2. METHODS

2a. Cancer Dataset and Analysis

The Connecticut Urinary Bladder Cancer data set (1965-2007) was obtained from the Connecticut Tumor Registry (CTR). The CTR is a population-based surveillance system that began collecting information in 1935 on Connecticut residents diagnosed with cancer. It is the oldest tumor registry in the country. All newly diagnosed cancers among Connecticut residents are required by law to be reported to the CTR. The bladder cancer dataset includes bladder cancers in male and female Connecticut residents diagnosed during the period 1965 through 2007. The year 2007 is the most recent year for which data were available at the time the dataset was requested from the CTR. Both invasive and in situ bladder cancers are included because of the difficulty in distinguishing between them. The following five data fields were provided for each cancer: a unique identifier, gender, year of diagnosis, age at diagnosis, and town of residence at diagnosis.

Using SAS 9.2.,1, the data set was sorted into nine time intervals for year of diagnosis (1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, and 2005-2007) and four age at diagnosis categories (<45, 45-64, 65-74, and 75+). These are the age breakdowns used in CTDPH's previous evaluations of cancer in Stratford. With the exception of the final time interval (2005-2007), each of the time intervals are 5-year periods. These time intervals are similar to the ones used in previous evaluations. To account for gender-related confounders, male and female cancer data were analyzed separately.

Using Microsoft Excel, bladder cancer incidence rates (rates are per 100,000 people) were calculated for Stratford and several geographic comparison areas. Geographic comparison areas are discussed in Section 2b. Age-stratified populations for each time interval were taken from a variety of sources. Table 1 in Appendix A presents the population source used for each of the nine time intervals and each of the three geographic comparison areas.

In making comparisons of cancer incidence by time period and geographic area, cancer incidence rates are often age adjusted to take into account changes in the age structure of the population.

The aging of the population, or the growing numbers of elderly persons, results in increases in total cancer rates because these rates rise with age. Age-adjusted rates were calculated using the age distribution of the entire U.S. population in 1990 as the standard (for consistency with previous evaluations of cancer in Stratford). These rates are presented in Table 2. The age-adjusted bladder cancer incidence rates for Stratford and for the comparison areas were then graphed over the nine time intervals. Figure 1 (in Appendix A) shows the incidence rates for male bladder cancer in Stratford and comparison areas. Figure 2 shows the same information for females.

To evaluate whether bladder cancer in Stratford is elevated for a particular time period, a standardized incidence ratio (SIR) was calculated. An SIR compares the number of cancers reported for a given geographic location (such as the town of Stratford) to the number that would normally be expected. The expected number of cancers is calculated based on the geographic location selected for comparison. Several geographic areas were selected for comparison with Stratford and are discussed in Section 2b.

An SIR greater than 1.0 indicates that there were more cases of bladder cancer reported in Stratford than were expected. Likewise, An SIR less than 1.0 indicates that there were fewer cases of bladder cancer reported in Stratford than were expected. For each SIR, a 95% Confidence Interval (95% CI) was calculated. A CI is a range around a value (in this case, the value is the SIR) that conveys how precise is the value. The 95% CI around the SIR means that 95% of the time the SIR is calculated, it will fall between the lower and upper ends of the 95% CI. A wide CI means that the SIR value is not very precise while a narrow CI means a more precise SIR. The width of the CI depends on the number of cases. When there are a small number of cases in the analysis, the range of the CI will be larger (indicating a less precise SIR) than when there is a large number of cases in the analysis.

CIs are important in interpreting the statistical significance of an SIR. An SIR is considered statistically significant if there is a small (less than 5%) chance that the observed difference is the result of random fluctuations in the number of cases. An SIR is considered statistically significant if the 95% CI does not include the value of 1. Table 3 contains all the SIRs (with

their 95% CIs) that were calculated. Table 4 presents the observed and expected numbers of cancers that were used to calculate the SIRs. The formulas used to calculate the SIR and Confidence Intervals are shown in Figures 3 and 4.

A statistically significant SIR does not necessarily indicate a finding of public health relevance. Statistically significant SIRs can still occur due to chance alone; there is just a relatively small likelihood that the observed difference is due to a random occurrence. In evaluating a statistically significant elevated SIR (i.e. an SIR greater than one with a 95% CI that does not include the value of 1), the magnitude of the SIR elevation is important. For example, an SIR of 5 (500% increase) is more suggestive of an important finding than an SIR of 1.5 (50% increase). As previously mentioned, the width of the CI is important too. The CI width reflects the stability of the SIR. A narrower CI (such as 2.1 to 2.2) indicates that the calculated SIR is more precise than an SIR that has a wide CI.

It is also important to look at trends over time when evaluating SIRs. As stated previously, SIRs were calculated for each comparison location and each of the nine time intervals. For each comparison location, SIRs over the nine time intervals were graphed to allow an examination of patterns over time. Figures 5 and 6 show the SIRs over time for male and female bladder cancer in Stratford using each of the three comparison areas.

In addition, SAS 9.2.1 was used to perform a linear regression analysis on the SIRs over time. A linear regression is a statistical technique used to identify a relationship between a target variable and other variables that could predict the target variable. The statistic helps one understand how much of the variance in one variable (SIR) can be explained by another variable (time interval for year of cancer diagnosis). The amount of association between the variables is expressed by an R-squared value. More specifically, an R-squared value is a measure of how much of the variance in the target variable (dependent variable) can be explained by the predictor variable(s) (independent variable(s)). R-squared values range from zero (none of the variance in SIR can be explained by time) to one (all of the variance can be explained). The linear regression analysis performed in this health study also included calculation of an F-value and a P-value, which are measures of the statistical significance of the regression equation. A high F-value and

low P-value means statistical significance. Table 5 contains the R-squared and F-values for each of the SIRs regression analyses.

2b. Selection of geographic comparison areas

Four geographic areas were initially selected for comparison with Stratford. These four areas are: towns surrounding Stratford, towns of similar population size as Stratford, the entire state of Connecticut, and the United States. For reasons that are discussed below, the United States was eliminated as a comparison location.

The state of Connecticut was selected because it was used as a comparison area in CTDPH's previous cancer evaluations in Stratford. CTDPH's 2001 cancer evaluation recommended that towns around Stratford be evaluated to observe whether apparent increasing male bladder cancer trends in Stratford exist in other areas. To address this recommendation, an appropriate comparison area needed to be defined. Initially, it was decided that towns surrounding Stratford (defined as towns with a common border with Stratford), would provide an appropriate comparison area. There are 5 such towns (Bridgeport, Milford, Orange, Shelton, and Trumbull). After further discussion, it was decided that another grouping of towns might provide a better comparison group than towns sharing a border with Stratford. This is because some of the towns sharing a border with Stratford might not be similar to Stratford with respect to such confounding variables as socioeconomic status, industrial history, or environmental exposures. It was decided that towns with similar population (and population density) might be more alike in terms of socioeconomic status and industrial history. Also, town population is more readily available than data on socioeconomic status or industrial history. Towns with a population within +/- 10,000 of the Stratford population were selected. There are 15 such towns, and they are listed in Table 6. These towns also have population densities that are relatively similar to Stratford.

For the United States, it was discovered that bladder cancer data is only available for seven years (1999 – 2005). Because such a minimal amount of data was available (compared with 42 years of data for the CT comparison areas), the United States was not used as a comparison location in the analyses.

3. RESULTS

Figure 1 shows the age-adjusted incidence of male bladder cancer in Stratford trending upward from 1965 to a peak during the 1985-1989 time interval. For time intervals after 1985-1989, the upward trend does not continue. The incidence rate drops down and then levels off.
Figure 1 also shows the trend over time in male bladder cancer incidence rates for the three comparison areas (State of CT, 15-towns of similar population, and 5 towns sharing a border with Stratford). Rates for the three comparison areas look very similar across all time intervals. This means that the two smaller comparison areas (5-town and 15-town) are not much different from the state as a whole, so all of the three areas seem to be equally good choices for comparison with Stratford.

Over the first 4 time intervals, all three comparison areas look very much like Stratford (a gradual increase in cancer incidence rates). However, in the 1985-1989 interval, incidence rates in the comparison areas do not peak like they do in Stratford. Rather, they show a gradual leveling off. The incidence rate in Stratford decreases in the 1990-1994 time interval and is again similar to all three comparison areas for the remaining time intervals.

Figure 2 shows age-adjusted bladder cancer incidence for females. Bladder cancer incidence rates for females are lower than for males in all time periods but the trends over time look similar to the male trends. Incidence rates in Stratford and the comparison areas gradually increase during the first 4 time intervals. Just like the male rates in Stratford, female rates peak during 1985-1989. In the comparison areas, trends in incidence rates are also similar to what is seen in Figure 1 for males (i.e. a general upward trend for the first four time intervals, then a leveling off).

To learn whether bladder cancer rates in Stratford are higher than expected for any of the time intervals, refer to Figures 5 and 6 and to Table 3. The two Figures show SIRs over time for bladder cancer in Stratford, as compared with each of the three comparison areas. For males (Figure 5), bladder cancer rates in Stratford were higher than expected (with statistical significance) during two time intervals (1980-1984 and 1985-1989). Statistical significance is

indicated in Table 3. Only during 1985-1989, were Stratford male rates higher (with statistical significance) as compared with all three comparison areas. For the 1980-1984 interval, Stratford male rates were elevated only when compared with the 15-town area. Figure 5 shows the general trend of increasing male bladder cancer rates in Stratford that was noted in previous evaluations of cancer in Stratford. However, after peaking in 1985-1989, Stratford rates do not continue to increase.

Figure 6 and Table 3 show that female bladder cancer was also higher in Stratford than expected (with statistical significance) during the 1985-1989 time period. This statistically significant elevation was seen only when Stratford was compared with the 5-town area. During the 1995-1999 time interval, Stratford has a statistically significant decrease in female bladder cancers, as compared with the 15-town area and the 5-town area.

The linear regression results in Table 5 indicate that there are no correlations between SIR and time (low R-squared values), regardless of which comparison area is used. The F-values and P-values indicate that the regression analysis is not statistically significant. This means that over all 9 time intervals evaluated, there is no statistically significant increasing or decreasing trend for male or female SIRs.

4. DISCUSSION

The findings of this study indicate that during the 1985-1989 time interval, male bladder cancer rates in Stratford were higher than expected as compared with all three comparison areas. While the elevation was not large (highest SIR = 1.57), it was statistically significant. Male bladder cancer was elevated in Stratford during one other time period (1980-1984), but only when Stratford was compared with the 15-town area. These elevations are not new findings in this study. They were observed in previous CTDPH studies. Also consistent with what was reported in previous cancer studies in Stratford, age-adjusted male bladder cancer incidence rates appear to trend upward from 1965 through the late 1980s. This general rise in bladder cancer incidence is also seen in the three comparison areas. However, the new data evaluated in this study shows that this upward trend does not continue beyond 1989 (in Stratford or the comparison areas).

Female bladder cancer in Stratford was also elevated during 1985-1989 but only in comparison with the 5-towns surrounding Stratford. The magnitude of the elevation (as measured by the SIR; 1.47) was slightly smaller than for males. Female bladder cancer SIRs did not show the same upward time trend as was seen in males. This is consistent with what previous cancer evaluations in Stratford showed. During the 1995-1999 time interval, Stratford had a statistically significant decrease in bladder cancers among females, as compared with the 5-town and the 15-town area. Similar to males, there is a gradual rise in age-adjusted bladder cancer incidence rates among females in Stratford, as well as the three comparison areas, during the first few time intervals.

While there appears to be a gradual rise in bladder cancer incidence rates during the early time intervals for both males and females, results of trend analyses over the entire 42 years of data shows that there is no statistically significant increasing or decreasing trend for male or female bladder cancer in Stratford, as compared with the three comparison areas.

Regarding the statistically significant elevation in bladder cancer in Stratford during the mid-late 1980s, it is not possible to determine the cause of the elevation. Likewise, it is not possible to determine the cause of the statistically significant decrease in female bladder cancer in Stratford in the mid-late 1990s. The typical latency period for bladder cancer is about 20 years or more. This means that if the bladder cancer increase in the 1980s was due to an environmental exposure, such exposure would have needed to occur in the late 1960s or earlier.

There are many confounding factors such as cigarette smoking, family history, and occupational exposure to bladder carcinogens that could not be accounted for in this analysis. It is also possible that the bladder cancer increase is due to chance or random variation. Finally, it cannot be ruled out that exposure to solvents from Raymark (air emissions from the Raymark facility, vapors from contaminated groundwater, solvents in Raymark waste products) caused or contributed to the increase. However, exposure to Raymark waste is not a very likely cause because the previous study of cancer in Stratford evaluated patterns of cancer in Stratford relative to known locations of Raymark waste and concluded that there were no statistically

significant increases in male or female bladder cancer as one moves closer to known Raymark waste sites.

4.1 Limitations

While this study does indicate that the previously observed gradual rise in bladder cancer in Stratford over time does not persist past the 1980s and is also seen in the three comparison areas, there are limitations in this study that should be acknowledged. As stated previously, there are confounding factors such as smoking, family history, and occupational exposure to bladder carcinogens that could not be accounted for in this analysis. Also, the US was not used as a comparison location because there were not enough years of data to make a comparison meaningful. It might have been informative to see how Stratford bladder cancer rates compared with national rates.

5. Conclusions

CTDPH reached the following four conclusions in this health consultation.

- Over the 42 years of data evaluated in this study, there is no increasing or decreasing trend for male or female bladder cancer in Stratford. Additionally, bladder cancer trends over time in the three geographic comparison areas are similar to Stratford.
- During the additional 11 years (1997-2007) evaluated in this new review, bladder cancer incidence rates in Stratford are not higher (with statistical significance) than bladder rates in any of the three geographic comparison areas.
- During the 1985-1989 time interval, male and female bladder cancer incidence rates in Stratford were higher than expected, as compared to the geographic comparison areas. During the 1995-1999 time interval, bladder cancer incidence rates in Stratford females were lower than expected, as compared to the geographic comparison areas. While these differences were not large, they were statistically significant. These are not new findings, these differences were observed in earlier CTDPH cancer studies.
- It is not possible to determine the cause of the statistically significant differences in bladder cancer in Stratford, as compared with the three geographic comparison locations. The evaluations conducted in this review examined bladder cancer incidence in Stratford as compared with three geographic comparison areas. It was not designed to examine causal relationships for cancer. There are many confounding factors that were not accounted for in this analysis. These factors might have been causes or contributing factors to cancer

increases or decreases. It is also possible that the cancer rate differences are due to chance or random variation. Finally, it cannot be ruled out that exposure to Raymark waste caused or contributed to the increase in bladder cancer in Stratford during the 1985-1989 time interval. However, this is unlikely because previous CTDPH studies of cancer in Stratford evaluated patterns of cancer cases in Stratford relative to known locations of Raymark waste and concluded that there were no statistically significant increases in male or female bladder cancer as one moved closer to known Raymark waste sites.

6. Recommendations

CTDPH makes the following two recommendations in this health consultation.

- Communicate the results and conclusions of this follow-up health study to the Stratford community. CTDPH will work with the Stratford Health Department and local community organizations to identify the most effective way to accomplish this.

- Address community concerns about exposure to Raymark waste and health effects via outreach and education, CTDPH will work with the Stratford Health Department and local community organizations to identify the most effective way to accomplish this.

References

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ATSDR 2003. Health Consultation: Evaluation of Indoor Air, Soil Gas and Groundwater Data Sampling Phases 2, 3, and 4 (2001, 2002, 2003), Raymark Industries. Prepared by the Connecticut Department of Public Health under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry, September 8, 2003.

APPENDIX A

TABLES AND FIGURES

Table 1. Sources for Historic Population Data (CT, Stratford, 5-Town and 15-Town) for each of the time intervals evaluated in the Follow-Up Review of Bladder Cancer in Stratford		
Time Interval	**State of CT**	**Towns**
1965-1969	45 Years of Cancer Incidence in CT (1935-1979), NCI Monograph 70[1]	1980 Census[2]
1970-1974	45 Years of Cancer Incidence in CT (1935-1979), NCI Monograph 70[1]	1980 Census[2]
1975-1979	45 Years of Cancer Incidence in CT (1935-1979), NCI Monograph 70[1]	1980 Census[2]
1980-1984	1980 Census[2]	1980 Census[2]
1985-1989	1990 Census[3]	1990 Census[3]
1990-1994	1990 Census[3]	1990 Census[3]
1995-1999	Mueller and Backus, 2007 (derived from 2000 Census)[4]	1990 Census[3]
2000-2004	Mueller and Backus, 2007 (derived from 2000 Census)[4]	Mueller and Backus, 2007 (derived from 2000 Census)[4]
2005-2007	American Community Survey (2005-2009)[5]	American Community Survey (2005-2009)[5]

Full citations:

[1] 45 Years of Cancer Incidence in Connecticut: 1935 – 1979, NCI Monograph 70 (1986), NIH Publication No. 86-2652.
[2] 1980 Census
[3] 1990 Census
[4] Muller LM, Backus KM, Stone CL. (2007) Town-level bridged race estimates for Connecticut, July 1, 2000, derived from 2000 Census, CTDPH.
[5] American Community Survey average annual population by town for the 5-year period 2005-2009, State, County and Town by Age and Sex.

Table 2. Age-Adjusted Incidence Rates of Bladder Cancer in Stratford, CT and Three Geographic Comparison Areas, with 95% Confidence Intervals (95% CIs[+]).

FEMALES	Time Interval	Stratford	95% CI[+]	5-Town[^]	95% CI	15-Town[#]	95% CI	CT[&]	95% CI
	1965-1969	6.8	(2.8, 10.9)	6.2	(4.5, 7.8)	4.7	(3.9, 5.6)	8.4	(7.7, 9.1)
	1970-1974	8.1	(3.9, 12.4)	8.1	(6.2, 10.0)	7.0	(5.9, 8.0)	9.1	(8.4, 9.9)
	1975-1979	10.0	(5.1, 14.9)	10.0	(8.0, 12.1)	8.4	(7.3, 9.6)	11.0	(10.3, 11.8)
	1980-1984	10.6	(5.5, 15.6)	8.6	(6.8, 10.5)	9.4	(8.2, 10.6	12.4	(11.6, 13.1)
	1985-1989	18.1	(11.9, 24.4)	8.7	(6.9, 10.5)	12.3	(11.0, 13.6)	11.9	(11.2, 12.6)
	1990-1994	16.7	(10.5, 22.9)	12.4	(10.3, 14.6)	12.1	(10.8, 13.5)	13.0	(12.3, 13.7)
	1995-1999	9.7	(5.2, 14.1)	11.6	(9.5, 13.7)	12.7	(11.4, 14.0)	13.0	(12.3, 13.7)
	2000-2004	13.0	(8.2, 17.8)	10.4	(8.5, 12.3)	11.1	(9.9, 12.2)	13.5	(12.8, 14.2)
	2005-2007	15.0	(7.6, 22.3)	11.5	(9.0, 14.1)	11.1	(9.6, 12.5)	13.1	(12.2, 14.0)
MALES	Time Interval	Stratford	95% CI	5-Town[^]	95% CI	15-Town[#]	95% CI	CT[&]	95% CI
	1965-1969	20.4	(13.5, 27.4)	24.1	(20.2, 27.9)	22.8	(20.6, 25.0)	24.8	(23.6, 26.0)
	1970-1974	23.6	(16.1, 31.2)	29.8	(25.5, 34.0)	27.8	(25.4, 30.2)	28.0	(26.7, 29.2)
	1975-1979	33.0	(24.0, 42.0)	31.6	(27.2, 36.0)	35.2	(32.5, 37.9)	30.7	(29.4, 32.0)
	1980-1984	39.2	(29.4, 49.1)	39.9	(35.0, 44.8)	40.3	(37.4, 43.2)	36.4	(35.0, 37.8)
	1985-1989	51.0	(40.2, 61.9)	34.4	(30.1, 38.8)	33.4	(31.2, 35.7)	35.3	(34.0, 36.6)
	1990-1994	41.7	(32.1, 51.3)	37.6	(33.0, 42.1)	34.4	(32.2, 36.7)	37.5	(36.2, 38.8)
	1995-1999	36.1	(27.1, 45.2)	37.5	(32.9, 42.1)	36.6	(34.2, 39.0)	35.1	(33.9, 36.2)
	2000-2004	40.9	(31.4, 50.3)	39.1	(34.7, 43.5)	39.5	(37.0, 42.0)	36.7	(35.5, 37.9)
	2005-2007	36.5	(25.0, 48.0)	35.5	(30.2, 40.7)	40.5	(37.2, 43.8)	36.0	(34.5, 37.5)

[^] 5 towns that share a border with Stratford
[#] 15 towns with population within +/- 10,000 of the Stratford population
[&] State of Connecticut
[+] 95% Confidence Intervals (CIs)

Table 3. Standardized Incidence Ratios of Bladder Cancer in Stratford, CT vs. Three Geographic Comparison Areas, with 95% Confidence Intervals (95% CIs[+]).							
FEMALES	**Time Interval**	**5-Town[^]**	**95% CI[+]**	**15-Town[#]**	**95% CI**	**CT[&]**	**95% CI**
	1965-1969	0.84	(0.42, 1.50)	1.12	(0.56, 2.00)	0.81	(0.40, 1.45)
	1970-1974	0.97	(0.53, 1.63)	0.99	(0.54, 1.66)	0.96	(0.52, 1.61)
	1975-1979	0.76	(0.44, 1.23)	0.92	(0.52, 1.48)	0.90	(0.51, 1.46)
	1980-1984	0.90	(0.53, 1.45)	0.88	(0.51, 1.40)	0.85	(0.50, 1.36)
	1985-1989	1.47*****	(1.01, 2.07)	1.12	(0.76, 1.57)	1.47	(1.00, 2.07)
	1990-1994	0.94	(0.62, 1.36)	0.99	(0.66, 1.43)	1.18	(0.78, 1.71)
	1995-1999	0.62*****	(0.37, 0.99)	0.59*****	(0.35, 0.93)	0.75	(0.44, 1.18)
	2000-2004	1.02	(0.68, 1.48)	0.99	(0.66, 1.44)	1.07	(0.71, 1.55)
	2005-2007	0.99	(0.57, 1.60)	1.00	(0.57, 1.63)	1.15	(0.66, 1.86)
MALES	**Interval**	**5-Town[^]**	**95% CI**	**15-Town[#]**	**95% CI**	**CT[&]**	**95% CI**
	1965-1969	0.91	(0.63, 1.29)	1.23	(0.85, 1.74)	0.88	(0.60, 1.24)
	1970-1974	0.85	(0.60, 1.16)	1.13	(0.80, 1.55)	0.90	(0.63, 1.23)
	1975-1979	1.10	(0.83, 1.45)	1.25	(0.94, 1.65)	1.11	(0.84, 1.47)
	1980-1984	1.02	(0.79, 1.33)	1.31*****	(1.01, 1.70)	1.12	(0.86, 1.45)
	1985-1989	1.47*	(1.18, 1.83)	1.57*****	(1.26, 1.95)	1.43*****	(1.15, 1.78)
	1990-1994	1.13	(0.89, 1.44)	1.27	(1.00, 1.61)	1.13	(0.89, 1.44)
	1995-1999	0.95	(0.73, 1.23)	1.00	(0.77, 1.30)	1.01	(0.78, 1.31)
	2000-2004	0.98	(0.77, 1.24)	1.14	(0.90, 1.45)	1.07	(0.84, 1.35)
	2005-2007	0.99	(0.70, 1.34)	0.96	(0.68, 1.30)	0.99	(0.70, 1.34)

[^] 5 towns that share a border with Stratford
[#] 15 towns with population within +/- 10,000 of the Stratford population
[&] State of Connecticut
*** Statistically significant at p < 0.05.**
[+]95% Confidence Intervals (CIs)

Table 4. Observed and Expected Bladder Cancers: Stratford CT and 3 Comparison Areas					
FEMALES	**Time Interval**	**Stratford (observed)**	**5-Town (expected)**	**15-Town (expected)**	**CT (expected)**
	1965-1969	11	13.1	9.8	13.6
	1970-1974	14	14.4	14.2	14.6
	1975-1979	16	21.0	17.5	17.8
	1980-1984	17	18.8	19.4	20.0
	1985-1989	32	21.8	28.7	21.8
	1990-1994	28	29.9	28.3	23.7
	1995-1999	18	28.8	30.7	24.0
	2000-2004	28	27.4	28.2	26.2
	2005-2007	16	16.2	15.9	13.9
MALES	**Interval**	**Stratford (observed)**	**5-Town (expected)**	**15-Town (expected)**	**CT (expected)**
	1965-1969	33	36.1	34.3	37.6
	1970-1974	38	44.7	41.8	42.3
	1975-1979	52	47.2	53.6	46.8
	1980-1984	61	59.6	60.8	54.6
	1985-1989	85	57.8	54.3	59.3
	1990-1994	72	63.5	56.8	63.7
	1995-1999	61	64.3	60.9	60.4
	2000-2004	72	73.7	72.2	67.6
	2005-2007	39	39.5	44.5	39.5

Table 5. Linear regression values for gender-specific Standardized Incidence Ratio (SIR) trends (1965-2007).				
GENDER	SIR Comparison Location	F-value	R-squared	P-value
MALE	5 Surrounding CT Towns	0.00	0.00	0.99
MALE	15 CT Towns of Similar Population	1.42	0.17	0.27
MALE	State of Connecticut	1.93	0.22	0.21
MALE	United States of America	0.17	0.03	0.69
FEMALE	5 Surrounding CT Towns	0.01	0.00	0.92
FEMALE	15 CT Towns of Similar Population	1.12	0.14	0.33
FEMALE	State of Connecticut	0.32	0.04	0.59

Table 6. 15 towns of similar population size to Stratford, CT.	
TOWN	**POPULATION**
Bristol	60,640
East Hartford	50,452
Enfield	45,532
Fairfield	53,418
Greenwich	58,441
Groton	45,144
Hamden	52,434
Manchester	51,618
Meriden	59,479
Middletown	42,762
Milford	49,938
Southington	38,518
Stratford	49,389
Wallingford	40,822
West Hartford	60,110
West Haven	54,021

Source: CT Population by Town 1970 – 2000, CT Department of Economic and Community Development, http://www.ct.gov/ecd/cwp/view.asp?a=1106&q=250676, accessed August 11, 2010.

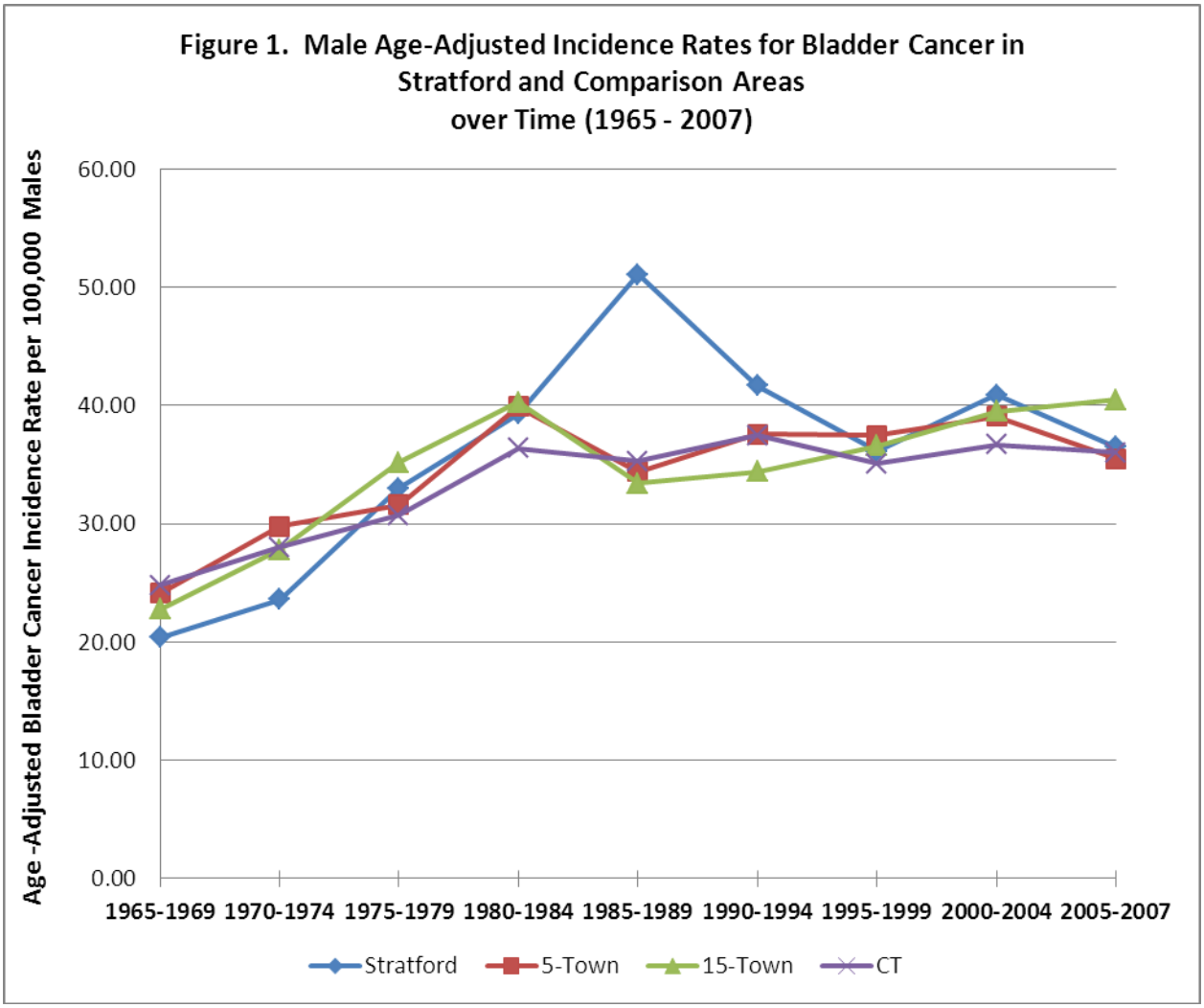


Figure 1. Male Age-Adjusted Incidence Rates for Bladder Cancer in Stratford and Comparison Areas over Time (1965 - 2007)
Age -Adjusted Bladder Cancer Incidence Rate per 100,000 Males
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1965-1969
1970-1974
1975-1979
1980-1984
1985-1989
1990-1994
1995-1999
2000-2004
2005-2007
Stratford
5-Town
15-Town
CT

Figure 2. Female Bladder Cancer Age-Adjusted Incidence Rates (AAIR) over Time in Stratford and Comparison Areas

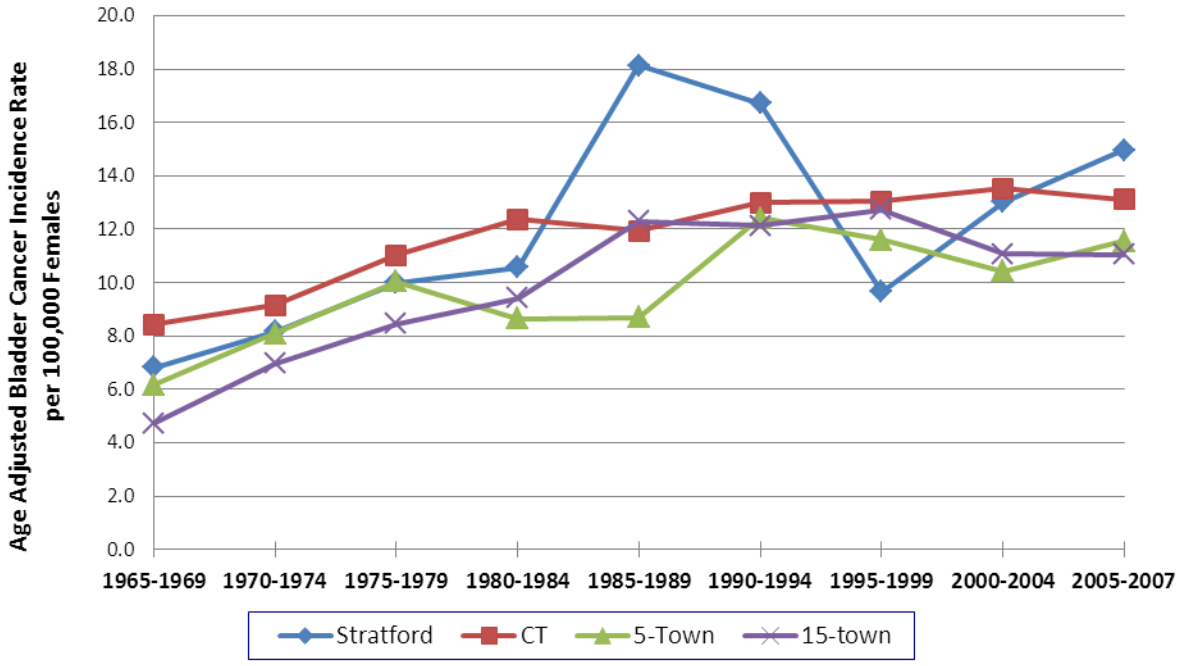


Figure 3. Formula for Calculation of Standardized Incidence Ratios

SIR = Observed UBC cases = Σ Observed Cases

Expected UBC cases Σ (Comparison Location Incidence rate X Age Stratum population)

= Σ Observed Cases

[(C.L. cases / C.L. <45 pop. X <45 Stratford pop.) + (C.L. cases / C.L. 45-64 pop. X 45-64 Stratford pop.)

+ (C.L. cases / C.L. 65-74 pop. X 65-74 Stratford pop.) + (C.L. cases / C.L. 75+ pop. X <45 Stratford pop.)]

Figure 4. Formula for Calculation of Standardized Incidence Ratio 95% Confidence Intervals

SIR 95% CI = SIR (SIR Lower, SIR Upper)

SIR 95% CI Lower = (Observed UBC Cases X Lower Limiting Factor) / Expected UBS Cases

SIR 95% CI Upper = (Observed UBC Cases X Upper Limiting Factor) / Expected UBS Cases

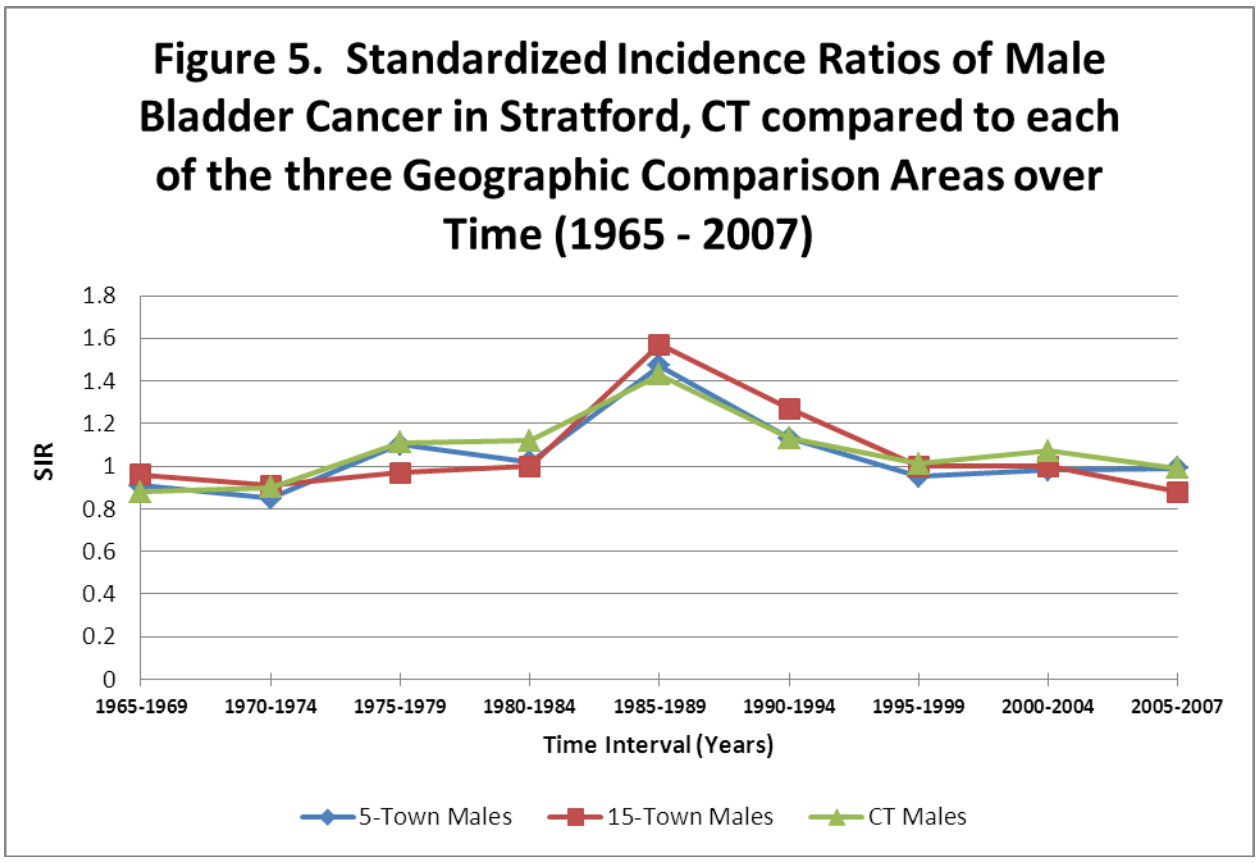
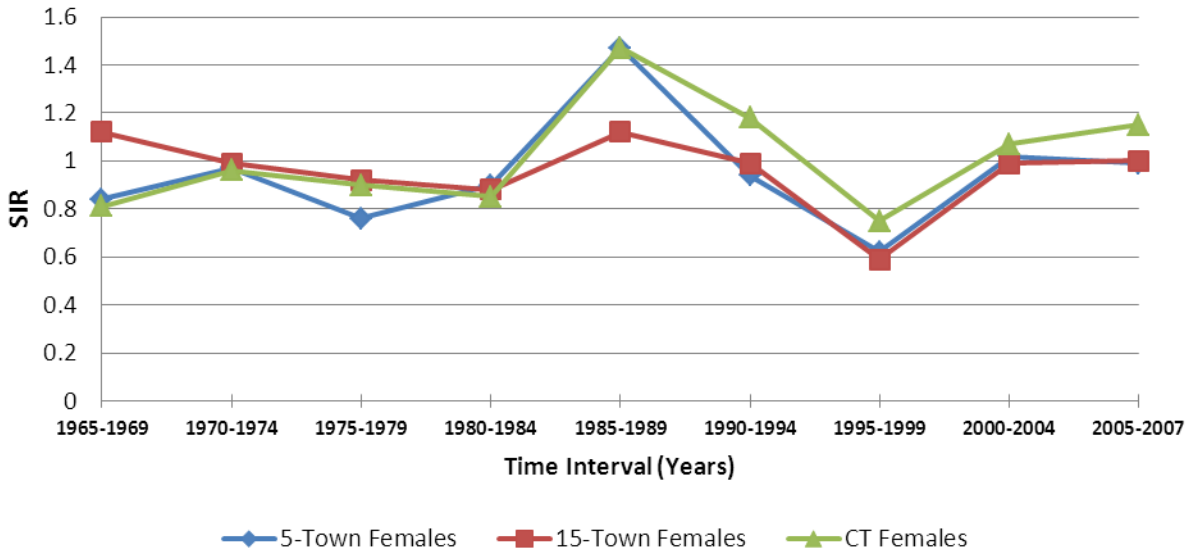


Figure 5. Standardized Incidence Ratios of Male Bladder Cancer in Stratford, CT compared to each of the three Geographic Comparison Areas over Time (1965 - 2007)
SIR
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1965-1969
1970-1974
1975-1979
1980-1984
1985-1989
1990-1994
1995-1999
2000-2004
2005-2007
Time Interval (Years)
5-Town Males
15-Town Males
CT Males

Figure 6. Standardized Incidence Ratios of Female Bladder Cancer in Stratford, CT compared to each of the three Geographic Comparison Areas over Time (1965 - 2007)



REPORT PREPARATION

This Health Consultation for the Raymark Industries Site was prepared by the Connecticut Department of Public Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented. ATSDR's approval of this document has been captured in an electronic database, and the approving agency reviewers are listed below.

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