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Evaluation of Leukemia, Liver Cancer, and Lung Cancer in Marlborough, Massachusetts: 1982-2002

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EVALUATION OF LEUKEMIA, LIVER CANCER, AND LUNG CANCER IN MARLBOROUGH, MASSACHUSETTS: 1982-2002

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I. INTRODUCTION

In May of 2000, the Massachusetts Department of Public Health, Center for Environmental Health (MDPH, CEH) released a Public Health Assessment for public comment for the Glen Street neighborhood area (a.k.a. Milham Brook area) in Marlborough, MA (MDPH 2000) (see Figures 1 and 2). The Public Health Assessment evaluated available environmental sampling data (i.e., surface soil and surface water) and the potential for health effects associated with historical pesticide use at a former apple orchard in this area of Marlborough. The Public Health Assessment was initiated when the CEH and the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) received a petition request expressing concern about illness, particularly cancer, in long-term residents living near the former orchard (Bucchino et al. 2000). Residents cited a number of concerns including a suspected increase in the incidence of cancers in the surrounding neighborhood and the known use of pesticides in the former orchard.

In 1999, the Board of Health for the City of Marlborough had contacted the CEH about a resident's concerns over the number of individuals with cancer, including leukemia, in the Conrad Road neighborhood of Marlborough. Conrad Road is in the same neighborhood as Glen Street. Also, in 1999, the Massachusetts Cancer Registry (MCR) released the report *Cancer Incidence in Massachusetts 1990-1995: City and Town Supplement* (MCR 1999). A preliminary review of these surveillance data for Marlborough indicated that the majority of cancer types occurred at or below expected rates during 1990-1995. However, it was noted that some cancer types were elevated and that the increases represented statistically significant increases in the number of diagnoses above the expected number of cases. Therefore the Public Health Assessment recommended additional investigation of the patterns or trends in the incidence of leukemia and lung and liver cancers at a smaller geographic level within Marlborough.

In response to these observations and to further address environmental health concerns of the community, the CEH's Community Assessment Program (CAP) evaluated the incidence of leukemia and cancers of liver and the lung in the city of Marlborough and for smaller geographic areas within the city for the 21-year time period 1982-2002. In addition, this evaluation includes a brief summary of the results of the Public Health Assessment for public comment regarding environmental contamination at the former apple orchard, as well as information regarding other sites of environmental concern in Marlborough, to determine the likelihood that potential environmental exposures could play a role in the pattern of cancer in the city. MDPH recently finalized the Public Health Assessment (MDPH 2006).

II. BACKGROUND AND STATEMENT OF ISSUES

As described in the Public Health Assessment (MDPH 2000), the former apple orchard in Marlborough comprises 82 acres and is bordered to the north by Route 20, to the east and south by Glen Street, and to the west by Ames Street (see Figure 2). Milham Brook, a tributary of Milham Reservoir and one of the drinking water sources for

Marlborough, runs through the site. The site was used as an apple orchard until the 1950s, during which time various pesticides, including lead arsenate, were applied. The primary contaminants of concern at the site included arsenic, 1,1,1-trichloro-2,2-bis[p-chlorophenyl]ethane (DDT) and related compounds [i.e., 1,1-dichloro-2,2-bis[p-chlorophenyl]ethylene (DDE) and 1,1-dichloro-2,2-bis[p-chlorophenyl]ethane (DDD)], and dieldrin.

Cancers or tumors of concern that have been associated or possibly associated with exposure to compounds detected at the former apple orchard property in Marlborough in either animal or human studies include cancers of the kidney (arsenic), liver (arsenic, DDT, and dieldrin), lung (arsenic), bladder (arsenic), thyroid (dieldrin), skin (arsenic), as well as Hodgkin's disease (DDT) and non-Hodgkin's lymphoma (DDT). Based on this information, the potential for environmental exposures at the former apple orchard, and a review of preliminary data on the incidence of cancer in Marlborough, the Public Health Assessment recommended further evaluation of three cancer types (i.e., leukemia, liver cancer, and lung cancer) in Marlborough, with particular attention to the Glen Street neighborhood (MDPH 2000).

III. OBJECTIVES

This report provides a descriptive evaluation of the occurrence of certain cancer types in the city of Marlborough. It provides a comparison of the incidence of selected cancer types in this community with the incidence of cancer in the state of Massachusetts as a whole. The state of Massachusetts is used as a comparison to provide a stable, standard population to calculate and compare cancer incidence rates. Additionally, available information about risk factors related to the development of cancer, including environmental factors, was evaluated.

Because the evaluation described in this report is a descriptive analysis of cancer incidence data, it cannot be used to establish a causal link between a particular risk factor and the development of cancer. In addition, this analysis cannot determine the cause of any one individual's cancer diagnosis. However, the results can be useful in identifying common patterns or trends in cancer incidence in a geographic context. This type of analysis can be helpful in determining if a common etiology (or cause) for certain cancer types is possible and can serve to identify areas where further public health investigations or actions may be warranted. Descriptive analyses may also indicate that an excess of known risk factors associated with a particular cancer type exists in a certain geographic area. Despite their limitations, descriptive studies can help identify patterns that may indicate an environmental exposure is related to a pattern of cancer. The purpose of this investigation was to determine whether unusual patterns of cancer incidence existed at a smaller geographic level within Marlborough and specifically the Glen Street neighborhood of the city, and to evaluate whether future public health actions are warranted.

IV. METHODS FOR ANALYZING CANCER INCIDENCE DATA

A. Case Identification/Definition

Cancer incidence data (i.e., new diagnoses of cancer cases) for leukemia, liver cancer, and lung cancer were obtained for the city of Marlborough from the Massachusetts Cancer Registry (MCR), a division of the MDPH Center for Health Information, Statistics, Research and Evaluation. The MCR is a population based surveillance system that began collecting information on Massachusetts residents diagnosed with cancer in the state in 1982. All newly diagnosed cancer cases among Massachusetts residents are required by law to be reported to the MCR within six months of the diagnosis (M.G.L. C.111s.111B).

At the initiation of this investigation, the 21-year time period 1982-2002 constituted the period for which the most recent and complete cancer incidence data were available from the MCR. The observed number of cancer cases reported in this evaluation was defined as cases reported to the MCR as a primary cancer diagnosed among residents of Marlborough. Individuals were selected for inclusion based on the address reported to the hospital or reporting medical facility at the time of diagnosis.

The term "cancer" is used to describe a variety of diseases associated with abnormal cell and tissue growth. Epidemiology studies have revealed that different types of cancer are individual diseases with separate causes, risk factors, characteristics and patterns of survival (Bang 1996). Cancers are classified by the location in the body where the disease originated (the primary site) and the tissue or cell type of the cancer (histology). Therefore, each of the cancer types reviewed in this report was evaluated separately. Cancers that occur as the result of the metastasis or the spread of a primary site cancer to another location in the body are not considered as separate cancers and therefore were not included in this analysis.

Occasionally, the MCR research file may contain duplicate reports of cases. The data discussed in this report have been controlled for duplicate cases by excluding them from the analyses. Duplicate cases are additional reports of the same primary site cancer case. The decision that a case was a duplicate and should be excluded from the analyses was made by the MCR after consulting with the reporting hospital/diagnostic facility and obtaining additional information regarding the histology and/or pathology of the case. However, reports of individuals with multiple primary site cancers were included. A multiple primary cancer case is defined by the MCR as a new cancer in a different primary site, or a new cancer of the same histology (cell type) as an earlier cancer, if diagnosed in the same primary site (original location in the body) more than two months after the initial diagnosis (MCR 2003). Therefore, duplicate reports of an individual diagnosed with cancer were removed from the analyses whereas individuals who were diagnosed with more than one primary site cancer were included as separate cases. In the city of Marlborough during 1982-2002, 13 duplicate reports were identified and excluded from the analysis.

B. Calculation of Standardized Incidence Ratios (SIRs)

To determine whether elevated numbers of cancer cases have occurred in Marlborough or its census tracts (CTs), cancer incidence data were tabulated by age group and gender to compare the observed number of cancer cases in each census tract to the number that would be expected based on the statewide cancer experience. Standardized incidence ratios (SIRs) were calculated for the 21-year time period 1982-2002, for four smaller time periods (i.e., 1982-1986, 1987-1992, 1993-1998, and 1999-2002), for each of the three cancer types for the six census tracts in Marlborough and the city as a whole.

In order to calculate incidence rates, it is necessary to obtain accurate population information. The population figures used in this analysis were interpolated based on 1980, 1990 and 2000 U.S. Census data for each CT in Marlborough for the 1982-2002, 1982-1986, 1987-1992, and 1999-2002 time periods (U.S. Census Bureau 1980, 1990 and 2000). Midpoint population estimates were calculated for each time period evaluated. To estimate the population between census years, an assumption was made that the change in population occurred at a constant rate throughout the ten-year interval between each census. For example U.S. Census data for the years 1990 and 2000 were used to find the midpoint population for the 1993-1998 analysis. U.S. Census data for the year 2000 were used in the 1999-2002 analysis (U.S. Census Bureau 2000).

Because accurate age group and gender specific population data are required to calculate SIRs, the CT is the smallest geographic area for which cancer rates can be accurately calculated. Specifically, a CT is a smaller statistical subdivision of a county as defined by the U.S. Census Bureau. Census tracts usually contain between 2,500 and 8,000 persons and are designed to be homogenous with respect to population characteristics (U.S. Census Bureau 1990).

The location and boundaries of the Marlborough census tracts are illustrated in Figure 1. The U.S. Census Bureau has designated six census tracts (CTs 3211-3216) to subdivide the city of Marlborough. Census tracts 3211 and 3214 are the least populated census tracts and are located on the western and eastern sides of the city, respectively. The remaining four census tracts (i.e., 3212, 3213, 3215, and 3216) subdivide the remainder of the city. Each of these four census tracts contains a portion of the more populated city center. The Glen Street neighborhood and former orchard property are located in CT 3214 (see Figure 2).

C. Interpretation of Standardized Incidence Ratio (SIR)

An SIR is an estimate of the occurrence of cancer in a population relative to what might be expected if the population had the same cancer experience as some larger comparison population designated as “normal” or average. Usually, the state as a whole is selected to be the comparison population. Using the state of Massachusetts as a

comparison population provides a stable population base for the calculation of incidence rates.

Specifically, an SIR is the ratio of the observed number of cancer cases to the expected number of cases multiplied by 100. The population structure of each town is adjusted to the statewide incidence rate to calculate the number of expected cancer cases. The SIR reflects a comparison of the number of cases in the town compared to the statewide rate, using the specific age/sex structure of the statewide rate as the weights to determine the expected number of cases in each town. Therefore, because each community has different population characteristics, town-to-town or census tract comparisons are not possible.

An SIR of 100 indicates that the number of cancer cases observed in the population being evaluated is equal to the number of cancer cases expected in the comparison or "normal" population. An SIR greater than 100 indicates that more cancer cases occurred than expected an SIR less than 100 indicates that fewer cancer cases occurred than expected. Accordingly, an SIR of 150 is interpreted as 50% more cancer cases than the expected number; an SIR of 90 indicates 10% fewer cancer cases than expected.

Caution should be exercised, however, when interpreting an SIR. The interpretation of an SIR depends on both the size and the stability of the SIR. Two SIRs can have the same size but not the same stability. For example, an SIR of 150 based on four expected cases and six observed cases indicates a 50% excess in cancer, but the excess is actually only two cases. Conversely, an SIR of 150 based on 400 expected cases and 600 observed cases represents the same 50% excess in cancer, but because the SIR is based upon a greater number of cases, the estimate is more stable. It is very unlikely that 200 excess cases of cancer would occur by chance alone. As a result of the instability of incidence rates based on small numbers of cases, SIRs were not calculated when fewer than five cases were observed for a particular cancer type.

D. Calculation of the 95% Confidence Interval

To interpret or measure the stability of an SIR, the statistical significance of each SIR was assessed. The statistical significance of an SIR was assessed by calculating a 95% confidence interval (95% CI) for each SIR to determine if the observed number of cases is "significantly different" from the expected number or if the difference may be due solely to chance (Rothman and Boice 1982). Specifically, a 95% CI is the range of estimated SIR values that have a 95% probability of including the true SIR for the population. If the 95% CI range does not include the value of 100, then the study population is significantly different from the comparison or "normal population." "Significantly different" means there is less than a 5% chance that the observed difference (either increase or decrease) is the result of random fluctuation in the number of observed cancer cases.

For example, if a confidence interval does not include 100 and the interval is above 100 (e.g., 105-130), then this means statistically there is a significant excess in the number of cancer cases. Similarly, if the confidence interval does not include 100 and the interval is below 100 (e.g., 45-96), then statistically this means that the number of cancer cases is significantly lower than expected. If the confidence interval range includes 100, then the true SIR may be 100, and it cannot be concluded with sufficient confidence that the observed number of cases is not the result of chance. In this case, it cannot be determined with certainty that the difference between the observed number of cases reflects a real cancer increase or decrease. It is important to note that statistical significance does not necessarily imply public health significance. Determination of statistical significance is just one tool used to interpret SIRs.

In addition to the range of the SIR estimates contained in the confidence interval, the width of the confidence interval also reflects the stability of the SIR estimate. For example, a narrow confidence interval (e.g., 103-115) allows a fair level of certainty that the calculated SIR is close to the true SIR for the population. A wide interval (e.g., 85-450) leaves considerable doubt about the true SIR, which could be much lower than or much higher than the calculated SIR. This would indicate an unstable statistic. Again, due to the instability of incidence rates based on small numbers of cases, statistical significance was not assessed when fewer than five cases were observed.

E. Evaluation of Risk Factor Information

Available information reported to the MCR related to risk factors for cancer development was reviewed and compared to known or established incidence patterns for the cancer types evaluated in this report. This information is collected for each individual at the time of cancer diagnosis and includes age at diagnosis, histology (cell type), smoking status, and occupation. One or even several factors acting over time can be related to the development of cancer. For example, tobacco use has been linked to lung and bladder cancers. Other risk factors may include lack of crude fiber in the diet, high fat consumption, alcohol abuse, and reproductive history. Heredity, or family history, is an important factor for several cancers. To a lesser extent, some occupational exposures, such as jobs involving contact with asbestos, have been shown to be carcinogenic (cancer causing). Environmental contaminants have also been associated with certain types of cancer. The available risk factor information from the MCR was evaluated for the cancer types assessed for the city of Marlborough. However, information about personal risk factors (e.g., family history, hormonal events, diet, etc.) that may also influence the development of cancer is not collected by the MCR or any other available source and therefore was not evaluated in this investigation.

F. Geographic Distribution

The geographic distribution of individuals diagnosed with leukemia, liver cancer, or lung cancer in Marlborough was determined using available address information from the MCR indicating residence at diagnosis. This information was mapped for each individual using a computerized geographic information system (GIS) (ESRI 2005). This

allowed for the assignment of CT location for each case as well as an evaluation of the spatial distribution of cases at a smaller geographic level within census tracts (i.e., neighborhoods). The geographic distribution was assessed using a qualitative evaluation of the point pattern of cases within the city and within each census tract. In instances where the address information was incomplete (i.e., did not include specific streets or street numbers), efforts were made to research those cases using telephone books and city residential lists issued within two years of an individual's diagnosis. Address locations were also confirmed by site visits to the area. For confidentiality reasons, maps of the locations of individuals diagnosed with cancer cannot be provided in this report.

G. Cancer Incidence in the Glen Street Neighborhood

As described previously, this evaluation was prompted by concerns about a suspected increase in the incidence of cancers among residents of the Glen Street neighborhood, thought to be related to environmental contamination associated with the former apple orchard in Marlborough. To determine whether an atypical pattern of any type of cancer (in addition to leukemia, liver cancer, and lung cancer) exists in the Glen Street area of Marlborough, CAP staff reviewed MCR data files to confirm cancer diagnoses reported among residents of Glen Street and the adjacent streets including Mount Royal Avenue, Foley Road, McGee Avenue, Burns Road, Conrad Road, Ripley Avenue, Hurley Circle, Tucker Avenue, Flynn Avenue, Teller Street, MacKay Drive, and Sandini Street. As noted above, the 21-year period from 1982-2002 constitutes the time period for which the most complete and recent cancer incidence data are available from the MCR. However, we also reviewed MCR data files for cancer diagnoses in this area reported from 2003 to the present.[1]

V. RESULTS OF CANCER INCIDENCE ANALYSES

The following sections present cancer incidence rates for leukemia, liver cancer, and lung cancer for Marlborough and its individual census tracts for the 21-year time period 1982-2002, as well as for four smaller time periods (i.e., 1982-1986, 1987-1992, 1993-1998, and 1999-2002). Analysis by census tracts or smaller geographic area helps in understanding whether the elevated incidence of a certain cancer type observed city-wide may be explained by an increase in cases in a particular geographic area of the city. Tables 1 through 15 summarize cancer incidence data for Marlborough and its census tracts for the time periods evaluated in this report. Figures 3 through 5 also provide a summary of cancer incidence data by census tract in Marlborough. The locations and boundaries of census tracts in Marlborough are presented in Figure 1.

[1] Standardized incidence ratios beyond the year 2002 cannot be calculated due to incomplete cancer incidence data for the state in more recent years. Although all newly diagnosed cases of cancer are required to be reported to the MCR with six months of diagnosis (M.G.L. C.111 s. 111B), due to intensive efforts to ensure data quality, there is a significant lag time between diagnosis and reporting. Therefore data for more recent years (i.e., 2003 to present) cannot be considered complete. MCR data reported here are current through May 12, 2006.

A. Leukemia

1. Leukemia Incidence in Marlborough, MA

Overall, the incidence of leukemia in Marlborough, MA was statistically significantly elevated among males and females combined during the 21-year time period 1982-2002 (87 cases observed vs. 59.6 expected, SIR=146, 95% CI=117-180). When evaluated separately by gender, females experienced a statistically significant elevation in rates of leukemia compared to the statewide experience. The rate of leukemia in males approached statistical significance. Among females, 42 diagnoses were observed where 27.1 were expected (SIR=155, 95% CI=112-209). Also, 45 diagnoses of leukemia were reported among males in Marlborough where approximately 33 were expected (SIR=136, 95% CI=99-182). A summary of these data are provided in Table 1. Also, an additional seven diagnoses of leukemia were reported in Marlborough from 2003 to the present. This represents an average of two new cases of leukemia each year since 2003 compared to the average of four new cases per year during the 1982-2002 time period.

To determine whether temporal trends (or trends over time) in leukemia incidence may have occurred, incidence data were evaluated for four smaller time periods (i.e., 1982-1986, 1987-1992, 1993-1998, and 1999-2002). Review of these data revealed that residents of Marlborough, MA experienced elevated rates of leukemia during the first three time periods, but leukemia was not elevated in the most recent time period evaluated. These elevations were statistically significant for males and females combined during 1987-1992 and 1993-1998 as well as for males during 1987-1992 and females during 1993-1998. During 1982-1986, 16 individuals in Marlborough were diagnosed with leukemia compared to approximately 12 expected. During 1987-1992, a total of 26 diagnoses were reported where 14.4 were expected (SIR=180, 95% CI=118-264). During 1993-1998, 30 individuals in Marlborough were diagnosed with leukemia while approximately 18 cases were expected (SIR=165, 95% CI=111-236). Finally, 15 diagnoses of leukemia in Marlborough were reported to the MCR during 1999-2002 compared to about 16 expected (SIR = 94) (see Tables 2-5).

2. Leukemia Incidence in Marlborough Census Tracts

To determine whether the trends observed in the incidence of leukemia in Marlborough reflect increased rates in particular geographic areas of the city, incidence data were reviewed for each census tract in Marlborough. During the 21-year time period 1982-2002, leukemia occurred more often than expected in five of Marlborough's six census tracts. Therefore, based on these data, the increased rate of leukemia observed citywide does not appear to be attributable to an elevation in any one census tract alone. Residents in one census tract experienced statistically significant elevations in the incidence of leukemia. Specifically, in CT 3215, 23 individuals were diagnosed with leukemia where approximately 12 diagnoses were expected (SIR=197, 95% CI=125-295). This increase was the result of a statistically significant elevation in the incidence of leukemia among females in this census tract. In CT 3214, where the former orchard and Glen Street neighborhood are located, leukemia occurred at approximately the

expected rate; five individuals were diagnosed with leukemia in this census tract where approximately six diagnoses were expected. A summary of leukemia incidence by census tract for the time period 1982-2002 is provided in Table 1.

Although SIRs were not calculated for many of the census tracts in smaller time periods due to the small number of observed cases (i.e., less than five), the expected number of cases was calculated to determine whether excess numbers of leukemia diagnoses were occurring in any area of Marlborough over time. In general, with some exceptions, leukemia occurred approximately at or below the expected rates in most Marlborough CTs during the earliest time period evaluated, 1982-1986 (see Table 2). A statistically significant elevation was observed in CT 3215 due primarily to an elevation among males in this census tract during this time period. During 1987-1992, the observed number of leukemia diagnoses was within one or two cases of the expected number for most census tracts (see Table 3). In CT 3213, a statistically significant elevation of leukemia occurred. Again, the elevation was due to a statistically significant elevation among males where 6 cases were observed vs. 1.6 expected (SIR=366, 95% CI=134-796). Residents experienced higher than expected rates of leukemia in the majority of Marlborough CTs during 1993-1998 (see Table 4). In CT 3215, a statistically significant elevation was noted among females where 5 cases were observed vs. 1.6 cases expected. Males in CT 3215 experienced leukemia at a less-than-expected rate during 1993-1998. Again in the most recent time period of 1999-2002 the observed number of leukemia diagnoses was within one or two cases of the expected number for most census tracts (see Table 5). For most of the elevations observed, the wide confidence intervals associated with these elevations suggest that the calculated SIRs are somewhat unstable. In CT 3214, where the Glen Street neighborhood is located, leukemia occurred at about the rate expected during each of the time periods evaluated.

B. Liver Cancer

1. Liver Cancer Incidence in Marlborough, MA

During the 21-year time period 1982-2002, a statistically significant elevation in the incidence of liver cancer was observed among residents of Marlborough (28 observed vs. 18.0 expected, SIR=156, 95% CI=103-225). Liver cancer occurred more often than expected among both males and females when evaluated separately by gender (18 observed diagnoses among males vs. 13.0 expected; 10 observed diagnoses among females vs. 4.9 expected) (see Table 6). Also, an additional five diagnoses of liver cancer were reported in Marlborough from 2003 to the present. This represents an average of one new case of liver cancer each year since 2003 compared to the average of one new case per year during the 1982-2002 time period.

The overall rate of liver cancer in Marlborough observed during 1982-2002 was due to elevations in the incidence of this cancer type during three of the smaller time periods, 1982-1986, 1987-1992, and 1993-1998. During 1982-1986, five individuals were diagnosed with liver cancer versus 2.5 diagnoses expected. During 1987-1992, six diagnoses were reported where 3.7 were expected. During 1993-1998, ten diagnoses of

liver cancer were observed in Marlborough where 5.6 diagnoses were expected. However, none of these elevations was statistically significant. In the most recent time period, 1999-2002 seven diagnoses were reported when 6.2 were expected. Please refer to Tables 7-10 for a summary of these data.

2. Liver Cancer Incidence in Marlborough Census Tracts

The statistically significant elevation in the incidence of liver cancer observed in Marlborough during 1982-2002 was primarily due to elevations in census tracts 3213, 3215, and 3216 during this time period. The elevation observed in CT 3213 was statistically significant (9 diagnoses observed vs. 3.5 expected, SIR=257). However, the wide 95% confidence interval (117-488) indicates that this is a somewhat unstable statistic. The increase observed in liver cancer in this census tract was due to elevations observed among both males and females when evaluated separately. Approximately three additional diagnoses above the expected number of diagnoses occurred in females and two additional diagnoses in males. [Statistical significance could not be determined because of the small number of observed diagnoses (i.e., less than five) among males and females when evaluated separately.] In CTs 3215 and 3216, the elevations were based on about two or three liver cancer diagnoses over the expected number (CT 3215 – 6 observed vs. 3.3 expected; CT 3216 – 6 observed vs. 3.2 expected). Residents of CT 3214, where the Glen Street neighborhood is located, experienced liver cancer at about the expected rate (1 diagnosis observed vs. 1.6 expected) (see Table 6).

SIRs could not be calculated for liver cancer in Marlborough CTs during smaller time periods because of the small numbers of observed cases (i.e., less than five). However, the observed numbers of cases in each CT was compared to the expected number of cases to determine whether liver cancer was occurring at increased rates in Marlborough CTs over time. In general, liver cancer occurred approximately at or below expected rates in the majority of CTs during the four time periods evaluated. However, there were a few exceptions. For example, four individuals (two males and two females) were diagnosed with liver cancer in CT 3213 during 1982-1986 where less than one case was expected based on the population of this census tract and the statewide rate of liver cancer. In this same census tract, three diagnoses were reported during 1987-1992 where approximately one case was expected. During 1993-1998, liver cancer was diagnosed at the expected rate in CT 3213. In CT 3216, four cases of liver cancer were diagnosed during 1993-1998 where one case was expected. No cases had been diagnosed in CT 3216 during 1982-1986, and one case (vs. about one expected) was diagnosed during 1987-1992. For a summary of liver cancer incidence rates by census tract for the years 1982-1986, 1987-1992, 1993-1998 and 1999-2002, refer to Tables 7-10.

C. Lung Cancer

1. Lung Cancer Incidence in Marlborough, MA

The incidence of lung cancer was statistically significantly elevated in Marlborough during the 21-year time period 1982-2002. Specifically, 437 individuals

were diagnosed with lung cancer where approximately 394.8 diagnoses were expected (SIR=111, 95% CI=101-122). This elevation was primarily due to a statistically significant increase in lung cancer among males in this city (263 observed diagnoses vs. 225.2 expected, SIR=117, 95% CI=103-132). Lung cancer among females in Marlborough was slightly higher than expected during 1982-2002 (174 observed diagnoses vs. 169.7 expected, SIR=103) (see Table 11). Also, an additional 31 diagnoses of lung cancer were reported in Marlborough from 2003 to the present. This represents an average of nine new cases of lung cancer each year since 2003 compared to the average of 21 new cases per year during the 1982-2002 time period.

Analysis of trends over time suggests that incidence rates for lung cancer increased in Marlborough during 1982-1986 and 1987-1992, but declined in 1993-1998 and 1999-2002. During 1982-1986, residents of Marlborough experienced an increase in the incidence of lung cancer (84 cases observed vs. 77.6 expected), due to an elevation in the incidence of this cancer type among males (57 cases observed vs. 49.0 expected) (see Table 12). During 1987-1992, lung cancer was statistically significantly elevated among males and females combined (140 cases observed vs. 104.1 expected, SIR=134, 95% CI=113-159) and among males when evaluated separately (82 cases observed vs. 61.6 expected, SIR=133, 95% CI=106-165). Females in Marlborough also experienced an elevated rate of lung cancer during this time period (58 cases observed vs. 42.6 expected); however, this elevation was not statistically significant (see Table 13). During 1993-1998, lung cancer occurred about as expected based on the state rate (119 cases observed vs. 120.3 expected, SIR=99). Similar trends were observed among males and females when evaluated separately by gender (see Table 14). In the most recent time period 94 diagnoses were observed when 92.8 were expected (SIR=101). Males had an increased incidence of lung cancer (56 observed vs. 48.1 expected) while females experienced a decreased incidence of lung cancer (38 observed vs. 44.7 expected). Neither of these results was statistically significant (see Table 15).

2. Lung Cancer Incidence in Marlborough Census Tracts

During the 21-year time period 1982-2002, the incidence of lung cancer was elevated in three of the six Marlborough census tracts [CT 3212 (83 observed vs. 75.4 expected), CT 3213 (94 observed vs. 79.1 expected), and CT 3215 (85 observed vs. 75.0 expected)]. However, none of these elevations were statistically significant. Residents of CT 3214, where the Glen Street neighborhood is located, experienced lung cancer at a rate slightly greater than expected based on the state lung cancer experience (41 cases observed vs. 36.3 expected). Based on these data, it appears that the elevation in lung cancer incidence observed citywide cannot be attributed to an elevation in any one specific census tract alone in Marlborough (see Table 11).

In general, similar trends were observed when males and females were evaluated separately by gender. In CT 3213, males experienced a statistically significant elevation in lung cancer during 1982-2002 (65 observed diagnoses vs. 45.0 expected, SIR=144, 95% CI=111-184) whereas females experienced a lower-than-expected rate of lung cancer (29 observed diagnoses vs. 34.1 expected). Although lung cancer occurred at

elevated rates among males and females in the majority of CTs, no elevation other than for males in CT 3213 was statistically significant.

In general, no consistent patterns emerged when lung cancer incidence rates in Marlborough census tracts were evaluated by smaller time period. Lung cancer occurred more often than expected in CT 3211 during 1982-1986 and 1987-1992 but less often than expected during 1993-1998 and 1999-2002. Residents of census tracts 3212 and 3213 experienced lung cancer at approximately the rates expected during 1982-1986, at statistically significantly elevated rates during 1987-1992, and at lower than expected rates during 1993-1998. During the most recent time period, 1999-2002, CT 3212 experienced lung cancer incidence lower than expected while CT 3213 experienced a higher lung cancer incidence. Lung cancer occurred approximately at or near the expected rate in CT 3214, where the Glen Street neighborhood is located, during the first three time periods evaluated while in the latter time period the incidence of lung cancer was slightly higher than expected. In CT 3215, approximately one to four additional diagnoses of lung cancer occurred during each of the time periods; no elevation was statistically significant. Lung cancer occurred less often than expected in CT 3216 during 1982-1986, but more often than expected during the time periods 1987-1992 and 1993-1998. In the latter time period the incidence was about as expected. During 1993-1998, this elevation was due to a statistically significant elevation among females in CT 3216 (16 cases observed vs. 9.1 expected, SIR=176, 95% CI=101-286). Summaries of lung cancer incidence rates by census tract and time period are provided in Tables 12-15.

VI. EVALUATION OF RISK FACTOR INFORMATION

As discussed, cancer is a term that describes a variety of individual diseases. Epidemiological studies have generally shown that different cancer types have separate causes, patterns of incidence, risk factors, characteristics and trends in survival. Available risk factor information collected by the MCR related to age distribution as well as other factors related to the development of cancer (e.g., gender, smoking status, and occupation) was reviewed for individuals diagnosed with leukemia, liver cancer, and lung cancer in the city of Marlborough during the time period 1982-2002.

A. Leukemia

Leukemia is the general term applied to a group of different cancers, which occur in the blood forming organs and result in the formation of abnormal amounts and types of white blood cells in the blood and bone marrow. Individuals with leukemia generally maintain abnormally high amounts of leukocytes or white blood cells in their blood. This condition results in an individual's inability to maintain certain body functions, particularly a person's ability to combat infection.

In the United States, leukemia occurs at an approximate rate of 9.7/100,000 persons and accounts for nearly 4% of all cancer deaths (Miller et al. 1996). While this disease occurs most often among whites, it also occurs more often among men than women in all racial and ethnic groups (NCI 1996). In Massachusetts, leukemia represents about 2% of all cancers diagnosed each year (ACS 2005).

1. Histology (Cell Type)

There are four main subtypes of leukemia: acute lymphoid leukemia (ALL), acute myeloid leukemia (AML), chronic lymphoid leukemia (CLL), and chronic myeloid leukemia (CML). For the purpose of classification in this evaluation, if the histology type of the leukemia was not otherwise specified (NOS) or not classified as one of the four main subtypes (e.g., prolymphocytic or plasma cell leukemia), then the individual case was categorized as "other." Available information regarding the expected distribution of leukemia by histology types can vary considerably depending on coding methods, making comparisons of type-specific incidence rates from different cancer registries difficult (Linet and Cartwright 1996). In the state of Massachusetts during the time period 1982-2002, 34% of all leukemia cases were AML, 27% were CLL, 13% were ALL, 12% were CML, and 14% were other histology types.

In Marlborough between 1982-2002, 23% (n=20) of leukemia cases were of the CLL type and 14% (n=12) were diagnosed as ALL. Therefore, a total of 37% of individuals diagnosed with leukemia in the city of Marlborough were diagnosed with the lymphoid type of the disease. Myeloid leukemia accounted for 48% of the leukemias diagnosed in Marlborough. Approximately 37% (n=32) of the cases were diagnosed with AML and 11% (n=10) of the cases were diagnosed with CML between 1982-2002. The remaining 15% (n=13) of leukemia cases diagnosed in Marlborough were otherwise classified or classified as NOS. In general, the histology distribution of leukemia in Marlborough during 1982-2002 was similar to that seen statewide (see Figure 6).

One census tract, CT 3215, had a statistically significant elevation in leukemia during the 1982-2002 time period. The distribution of subtypes for this CT was as follows: Of the 23 individuals diagnosed with leukemia in CT 3215 nine (39%) were diagnosed with the AML subtype, six (26%) had the CLL subtype, two (9%) were diagnosed ALL, two (9%) were diagnosed with CML and four (17%) were diagnosed with a leukemia coded as "other." The distribution of histology types in this CT was consistent with the statewide experience (e.g., most common subtypes were AML and CLL, consistent with state experience).

To assess possible trends over time, the histology distribution was also reviewed for each smaller time period evaluated in this report (see Figures 7, 8, 9 and 10). Based on these data, no clear patterns or trends in the incidence of leukemia are indicated with respect to histology subtype. Therefore, overall, it does not appear that the distribution of leukemia cases by histology represents an atypical or unexpected pattern.

2. Gender/Age Distribution

The four main types of leukemia have notable differences in their age distribution (NCI 1996). While ALL occurs predominantly among children, an elevation in incidence is also seen among older individuals. The increase in incidence among older individuals begins at approximately 40-50 years of age, peaking at about age 85 (Linet and Cartwright 1996). A similar age breakdown was observed in Marlborough, as ten of the 12 ALL cases during 1982-2002 were children (0-19 years) and the two other diagnoses

of ALL reported were in older individuals (i.e., above age 65). The occurrence of childhood leukemia (ten with ALL histology and one with CML histology) during 1982-2002 was elevated (11 observed vs. 6.6 expected), with the elevation attributed to a statistically significant elevation among male children (9 observed vs. 3.7 expected; SIR=243, 95% CI=111-462) (See Table 16).

When evaluated by census tract, the 11 diagnoses of leukemia among children during 1982-2002 had the following distribution: one child each in CTs 3211, 3212, 3213, two children each in CTs 3214, 3215 and four children in CT 3216. Thus, there did not appear to be an unusual distribution of childhood leukemia in any one CT.

CLL rarely occurs before age 30, after which the incidence increases rapidly with increasing age. The majority of CLL diagnoses (i.e., 90%) occur in people over 50 years old (Miller et al. 1990). In Marlborough between 1982-2002, there were 20 individuals diagnosed with the CLL histology type reported to the MCR, and all but one of these individuals were over the age of 50.

AML presents a trend of increased incidence among people of advancing age. This is especially evident at or after age 55, where the incidence of AML increases rapidly (LSA 1999a). Nineteen of the 32 individuals diagnosed with AML in Marlborough (59%) were over the age of 55. The age range of the other 13 individuals was between 20 and 54 years of age. CML can occur at any age, but is most often observed in individuals from age 30-50 years old. Of the ten cases of CML reported in Marlborough for the 1982-2002 period, two individuals were between the ages of 30 and 50 at the time of diagnosis, seven individuals were 55 years of age or older and the remaining individual was under the age 30. Seventy-seven percent (n=10) of the 13 individuals classified with the leukemia type "other" were over the age of 50.

As mentioned previously, CT 3215 experienced statistically significant elevations of leukemia during 1982-2002 time period. AML and CLL were the two most common subtypes in this census tract. The distribution of ages at diagnosis for individuals with AML and CLL in these census tracts was similar to the distribution of ages for AML and CLL in the town and state as a whole. Six of the nine individuals with AML (67%) were over the age of 55 and all six individuals with CLL in CT 3215 were over the age of 55.

Leukemia occurs more often among men than women in all racial groups (NCI 1996). Rates for all types of leukemia are higher in males than in females. In Marlborough during the 1982-2002 time period, 52% of leukemia diagnoses were male, whereas 48% of leukemia diagnoses were female.

3. Temporal Distribution

In order to help identify variations in cancer incidence over time, individuals with leukemia in Marlborough were examined by their dates of diagnosis. As shown in Figure 11, the dates of diagnosis varied throughout the 21-year time period 1982-2002, indicating no temporal concentration of diagnoses. In addition, there was no apparent increasing or decreasing trend in the number of diagnoses over time. In general, within

each year, individuals were diagnosed with different subtypes of the disease. For example, among the six individuals who were diagnosed with leukemia in 1996 five different leukemia subtypes were diagnosed. When evaluating the 11 children diagnosed with leukemia during 1982-2002, the temporal distribution of diagnoses was as follows: one diagnosis each in 1982, 1983, 1992, 1993, 1996, 1997, 1998, 1999, 2000 and two diagnoses in 1991. Thus, there was no apparent temporal concentration of childhood leukemia within Marlborough.

4. Occupation

Epidemiological research over the past twenty-five years has revealed patterns of incidence and risk factors that vary for each subtype of leukemia. While there are known and suspected risk factors for each subtype, leukemia cases are relatively rare, and despite a large body of research, risk factors that have been identified for different leukemia subtypes only account for a small number of cases (Linet and Cartwright 1996). Evaluation of the role of occupation in leukemia in Marlborough is made difficult by the large number of recognized leukemia subtypes, only some of which may be associated with a specific exposure. Findings are often inconsistent within a particular industry because specific leukemogenic (leukemia causing) exposures have not been identified for many occupations (Linet and Cartwright 1996).

Exposure to ionizing radiation is a known environmental risk factor associated with the development of ALL. Few other risk factors for this type of leukemia have been identified. Some studies have identified an increased risk of developing CLL among farmers and cigarette smokers, although, findings are conflicting and no specific exposure has been clearly identified (Linet and Cartwright 1996). High dose radiation exposure (i.e., nuclear weapon detonation), exposure to benzene, and exposure to alkylating agents (e.g., melphalan, cyclophosphamide) have been associated with increased risk of developing AML. Other occupational exposures to solvents such as toluene or butadiene in the shoe and rubber industries have not been shown to increase leukemia risk (LSA 1999a; NCI 1995; Linet and Cartwright 1996). Hair dyes have also been investigated extensively without a conclusive risk demonstrated. Other professions that have been associated with an increased risk of AML include embalmers, anatomists, pathologists and nurses handling antineoplastic drugs. Some associations have also been observed in metal mill, aluminum, and foundry workers. The only known environmental risk factor for CML is exposure to ionizing radiation (based on studies of atomic bomb survivors).

Occupation as reported to the MCR at the time of diagnosis was reviewed for each individual diagnosed with leukemia in Marlborough. Of the 87 individuals diagnosed with leukemia during 1982-2002, 11 were children and therefore did not have occupations. Review of this information for adults revealed occupations that for the most part, are not thought to be associated with the development of leukemia. However, the occupational data reported to the MCR are limited to job title and do not include specific-job duty information that could further define exposure potential for individual cases. Of the 76 adults diagnosed with leukemia in Marlborough during 1982-2002, occupational information reported to the MCR was listed as “unknown,” “retired,” or “homemaker”

for 32 (42%) of the individuals. Three out of 76 individuals (4%) reported occupations in which exposure to solvents (i.e., benzene) or ionizing radiation may have been possible, but without more specific job duty information it is difficult to assess the role their occupation may have played in the development of their leukemia.

5. Other Risk Factors

Each of the four main types of leukemia has genetic and unique risk factors associated with them. There is evidence that genetics may have a role in the development of ALL. Studies indicate that if one of a pair of homozygotic (identical) twins is diagnosed with leukemia, the other twin, who has the same genetic makeup, is at increased risk of developing the disease (Schuz et al. 1999). Children diagnosed with chromosome disorders such as Down syndrome and Bloom's syndrome are also at an increased risk of developing ALL (Linet and Cartwright 1996). Genetics, viruses, and diseases of the immune system have been suggested as playing a role in the development of CLL. It is thought that individuals with a family history of CLL are three times as likely to develop the disease (LSA 1999b). Congenital disorders and genetic factors have also been associated with the development AML. Bloom's syndrome has been observed among older individuals diagnosed with AML. Klinefelter's syndrome has also been identified among individuals diagnosed with this disease (Linet and Cartwright 1996). One of the only known risk factors for CML besides ionizing radiation is chromosome abnormalities such as the Philadelphia chromosome (Golde and Guliti 1994; Higgenson et al. 1992). Among individuals diagnosed with CML, more than 90% are identified as having this unique chromosome disorder (NCI 1995). It should be noted that family histories and/or medical records of individuals diagnosed with leukemia in Marlborough were not available in this cancer assessment and therefore could not be evaluated.

Finally, patients who are treated with radiation therapy and/or chemotherapy for other cancers have a slight risk of developing secondary leukemia (especially AML) later in life. Review of data from the MCR identified eight individuals (9%) diagnosed with leukemia in Marlborough during 1982-2002 who had been previously diagnosed with a different primary site cancer. These patients may have received treatment that could have contributed to their subsequent leukemia diagnosis. Again, because medical records were not available, it was not possible to determine whether these individuals actually received radiation therapy or chemotherapy for their cancer.

6. Residential History

Cancer in general has a long period of development or latency period (i.e., the interval between first exposure to a disease-causing agent and the appearance of symptoms of the disease [Last 1995]) that can range from 10 to 30 years and in some cases may be more than 40 to 50 years for solid tumors (Bang 1996; Frumkin 1995). However, the latency period for hematologic malignancies (i.e., cancers of the blood or bone marrow) is in the range of 4 to 5 years (Frumkin 1995). Although it is not possible to determine what may have caused any one person's diagnosis with cancer, the length of time in which an individual lived in a particular residence can help determine the importance that their location might have in terms of exposure to a potential

environmental source. Therefore, residential histories were constructed for Marlborough residents diagnosed with leukemia in order to determine how long they resided in their residence prior to diagnosis. Because shorter periods of residence can represent a significant portion of a child's life, residential histories for children ages 0-19 were evaluated separately. Information for residential histories was obtained from annual resident lists for the city of Marlborough (City of Marlborough 1970-2001).

Based on the information reviewed for the 76 adults diagnosed with leukemia in Marlborough between 1982-2002, 63% (n=48) had lived at their address five or more years prior to diagnosis and 20% (n=15) had lived at their address for less than five years prior to diagnosis. Residential histories could not be confirmed for 17% (n=13) of the individuals and therefore these individuals likely only lived at their address for a short time (e.g., less than one year) prior to diagnosis.

Residents of CT 3215 experienced a statistically significant elevation in the incidence of leukemia during the 21-year time period 1982-2002. Of the 23 adults diagnosed in this CT, 57% (n=13) lived at their reported address for at least five years prior to diagnosis. Five individuals had lived at their address for less than five years prior to diagnosis. Residential histories could not be confirmed for five individuals in CT 3215.

Between 1982-2002, 11 children ages 0-19 were diagnosed with leukemia in Marlborough. Based on a surname search of Marlborough resident lists, three of these children appeared to have lived at their reported address since birth and four school-aged children had lived at their reported address at least since they were toddlers. The families of the remaining four children could not be identified in city resident lists indicating that these families likely only lived at their address for a short time prior to the child's leukemia diagnosis.

B. Liver Cancer

Hepatocellular carcinoma (HCC) is the most common primary cancer of the liver (El-Serag and Mason 1999). HCC occurs most frequently in Asia, Africa and the Mediterranean basin (Akrividas et al. 1998). Liver cancer rates can vary substantially by country and although more than 80% of liver cancer cases occur in the developing world, incidence is rapidly increasing in the United States (Stuver 1998; Ince and Wands 1999).

1. Gender/Age Distribution

In the United States, men are more likely than women to develop HCC and blacks are affected twice as often as whites (El-Serag and Mason 1999). Although the risk of developing HCC increases with increasing age, the disease can occur in persons of any age. The median age of individuals diagnosed with liver cancer in Marlborough between 1982-2002 was 69 years old. Ninety-six percent of the cases (n=27) were greater than 50 years old at the time of diagnosis. In Marlborough, eighteen males and ten females were diagnosed with liver cancer between 1982-2002.

During the 21-year time period 1982-2002 in census tract 3213, where a statistically significant elevation in liver cancer was observed, seven of the nine individuals were over the age of 70. Five individuals were male and four were females. Between 1982-2002, in CT 3214, the location of the Glen Street area, one male over age 70 was diagnosed with liver cancer.

2. Personal Risk Factors

Chronic infection with the hepatitis B virus (HBV) and hepatitis C virus (HCV) are major risk factors for developing HCC (Fattovich 1998). In fact, scientists estimate that 10 to 20% of people infected with HBV will develop cancer of the liver. HBV is very common in Africa, China, and the Middle East. It has been estimated that approximately 4 million persons in the United States have chronic HCV infection (Ince and Wands 1999). Risk factors for the transmission of HBV and HCV include intravenous drug use, sharing of needles, unsafe sexual practices and transfusion of and contact with unscreened blood and blood products (El-Serag and Mason 1999). In addition, mothers who are infected with these viruses can pass them on to their children.

In addition, numerous epidemiological studies have identified chronic alcohol consumption as a significant risk factor associated with liver cancer (Seitz et al. 1998). Although alcohol is not a carcinogen itself, laboratory studies have shown that it may act as a cocarcinogen in the development of HCC (El-Serag and Mason 1999). Some studies have suggested that alcohol and chronic HCV infection may act in concert with one another to accelerate liver disease and damage. One study conducted in Italy showed that people with alcoholism and HCV infection often developed liver disease, which was followed by cirrhosis and the development of HCC (Bellantani et al. 1994).

Cirrhosis is perhaps the most important risk factor related to the development of HCC. Cirrhosis is a progressive disease, which causes inflammation and scar tissue to form on the liver. Scientists have estimated that 70 to 90% of individuals diagnosed with HCC also have cirrhosis (Johnson 1996). Other risk factors associated with the development of HCC such as alcoholism and HBV and HCV infection also cause cirrhosis. Personal risk factor information was not available for individuals diagnosed with liver cancer in Marlborough and was therefore not evaluated in this report.

3. Occupation

Additional risk factors related to the development of liver cancer include long-term exposure to aflatoxins, vinyl chloride, and thorium dioxide. Aflatoxins are carcinogenic agents produced by a fungus found in tropical and subtropical regions. Individuals may be exposed to aflatoxins if they consume peanuts and meal that have been stored under hot, humid conditions (Bellantani et al. 1994). Vinyl chloride has been primarily used in the United States to make polyvinyl chloride (PVC), which is used to make a variety of plastic consumer products and home furnishings (ATSDR 1997). Vinyl chloride is a known human carcinogen and occupational exposure to this chemical has been associated with the development of a specific type of liver cancer called angiosarcoma. Radioactive thorium dioxide was widely used in clinical medicine as a

diagnostic agent in Europe and Japan until 1950. Research has shown that fifteen years following exposure, the development of cirrhosis and HCC occurred in individuals who were exposed to this compound (Bellantani et al. 1994). The impact of both thorium dioxide and vinyl chloride was much greater in the past, since thorium dioxide has not been used for decades and exposure of workers to vinyl chloride is now regulated (ACS 1999). However, given the lengthy latency (development) period for most cancer types (i.e., 20 or more years), it is possible that individuals diagnosed with liver cancer during the 1980s and 1990s, consistent with the time period evaluated in this report, could have had an occupational exposure that contributed to their disease. Finally, liver cancer has also been associated with exposure to arsenic, DDT, and dieldrin. Large-scale epidemiological studies have shown an association between arsenic and liver cancer while several animal studies have shown that DDT and dieldrin causes liver cancer in mice and rats (ASTDR 1993a, 1993b, and 1994).

Of the 28 individuals diagnosed with liver cancer in Marlborough between 1982-2002, occupation was reported as "retired" or "unknown" for 36% (n=10). Review of occupational information for the remaining individuals did not indicate any jobs that have been associated with the development of liver cancer. However, occupational information reported to the MCR is limited to job title and does not contain specific job duty information that would provide a better indication of potential exposures. In addition, occupational information as reported to the MCR is not historical, that is, information regarding former occupations that may have been associated with potential exposures is not included.

C. Lung Cancer

Lung cancer generally arises in the epithelial tissue of the lung. Several different histologic or cell types of lung cancer have been observed. The various types of lung cancer occur in different regions of the lung and each type is associated with slightly different risk factors, although smoking is the primary risk factor for all types of lung cancer (Blot and Fraumeni 1996). The most common type of lung cancer in the United States today is adenocarcinoma (Thun et al. 1997).

1. Gender/Age Distribution

The incidence of lung cancer increases sharply with age peaking at about age 60 or 70. Only two percent of lung cancers occur before the age of 40. Lung cancer incidence is greater among men than women and greater among blacks than whites. The highest rates of lung cancer have been reported among urban black men (Blot and Fraumeni 1996). Trends in lung cancer incidence have revealed that the disease has become increasingly associated with populations of lower socioeconomic status, since these individuals may be more likely to be smokers (Blot and Fraumeni 1996).

In Marlborough during 1982-2002, less than one percent of individuals diagnosed with lung cancer were diagnosed before the age of 40. The mean age of individuals diagnosed with lung cancer in Marlborough during this time period was 68 years old. The majority of individuals (93%) were age 50 years or older at the time of diagnosis. In

Marlborough, 263 males and 174 females were diagnosed with lung cancer between 1982-2002. Lung cancer was statistically significantly elevated among males when compared with statewide cancer incidence.

In CT 3213, where a statistically significant elevation was observed among males, 65 males were diagnosed with lung cancer between 1982-2002, compared to approximately 45 expected diagnoses. The mean age of males diagnosed with lung cancer in this census tract was approximately 70 years.

In CT 3214, where the Glen Street neighborhood is located, among the 41 individuals diagnosed with lung cancer during 1982-2002, 23 were males and 18 were females. The average age of diagnosis was 67 years.

2. Smoking Status

Smoking is the most important known risk factor associated with the development of lung cancer. In 1985, an estimated 90% of lung cancer cases among men and 79% among women were attributed to cigarette smoking (Blot and Fraumeni 1996). More recently, an increase in cigarette smoking among women has produced lung cancer incidence rates that more closely resemble those experienced by males. The risk of developing lung cancer depends on the intensity of one's smoking habits (i.e., duration of habit, amount smoked, tar yield of cigarette, and filter type). Further, this risk declines after smoking cessation. However, investigators estimate it can take ten to twenty years of not smoking for long term, heavy smokers to reduce their risk of developing lung cancer. Studies suggest that the risk for developing lung cancer will always be about twice as high for ex-smokers compared to non-smokers (Blot and Fraumeni 1996). In Massachusetts as a whole, 78% of individuals diagnosed with lung cancer during 1982-2002 were current or former smokers at the time of diagnosis, 7% were non-smokers, and smoking history was unknown for the remaining 15% of individuals.

Information regarding smoking status as reported to the MCR was reviewed for individuals in Marlborough diagnosed with lung cancer. A total of 437 individuals were diagnosed with cancer of the lung in Marlborough between 1982-2002. Trends in smoking history for these individuals were consistent with those observed statewide. In Marlborough, approximately 80% (n=350) of individuals diagnosed with lung cancer during 1982-2002 reported being current or former smokers at the time of diagnosis while 6% (n=25) reported being non-smokers. Smoking status was unknown for approximately 14% (n=62) of the cases (see Figure 12). Therefore, of those for whom smoking status was known (n=375), approximately 93% (n=350) reported their smoking status as a current or former smoker and 7% (n=25) reported that they never smoked.

A total of 65 lung cancer cases were diagnosed among males in CT 3213, where a statistically significant elevation was observed between 1982-2002. Approximately 83% of these individuals reported being current or former smokers at the time of diagnosis, 6% were non-smokers, and smoking status was unknown for 11% of individuals (see Figure 13).

In CT 3214, where the Glen Street neighborhood is located, 73% of the individuals diagnosed with lung cancer between 1982-2002 reported being current or former smokers at the time of diagnosis, 15% were non-smokers, and smoking status was unknown for 12% of the individuals.

3. Occupation

Occupational exposure has also been identified as playing a role in the development of lung cancer. Occupations such as underground miners, chemical workers, paper and pulp workers, carpenters, butchers and meat packers, and shipyard workers are some of the occupations associated with increased risk of developing this cancer type. This is a result of exposure to chemical compounds that may be found in such workplaces such as arsenic, asbestos, chloromethyl ethers, chromium, vinyl chloride, and ionizing radiation. In addition, the occupational exposure to such compounds in conjunction with cigarette smoking dramatically increases the risk of developing lung cancer (Blot and Fraumeni 1996).

Exposure to radon (a naturally occurring gas produced by the breakdown of radium and uranium) has been associated with increased risk of developing lung cancer (Blot and Fraumeni 1996). Exposure to radon gas by underground miners is recognized to cause lung cancer. Risk projections in a number of studies suggest that radon is the second leading cause of lung cancer after smoking (Samet and Eradze 2000).

Occupation as reported to the MCR at the time of diagnosis was reviewed for each individual diagnosed with lung cancer in Marlborough. Review of this information revealed occupations that for the most part, are not thought to be associated with the development of lung cancer. However, between 1982-2002, 32 individuals (7%) reported occupations where exposure to lung cancer carcinogens may have been possible. Of note, the occupational data reported to the MCR are limited to job title and do not include specific-job duty information that could further define exposure potential for individual cases. In addition, occupational information reported to the MCR was reported as "retired," "at home," or "unknown" for approximately 33% of the individuals (n=143) diagnosed with lung cancer in Marlborough during the 21-year time period 1982-2002. For these reasons it is not possible to evaluate the degree to which these individuals' occupations may have contributed to the elevated lung cancer incidence rates in Marlborough. However, based on the information reviewed, it is plausible that occupation may have played a role in the development of lung cancer among at least some residents of Marlborough during the period of 1982-2002.

VII. GEOGRAPHIC DISTRIBUTION

In addition to quantitatively determining the census tract-specific incidence ratios for leukemia, liver cancer, and lung cancer, a qualitative evaluation was conducted to determine whether individuals with these cancer types appeared to be geographically concentrated in some area(s) within any of the six census tracts in Marlborough. Place of

residence at the time of cancer diagnosis was geocoded or mapped using a geographic information system (GIS), to assess any possible geographic concentration of diagnoses. As previously mentioned, cancer is one word that describes many different diseases. Therefore, for the purposes of this evaluation, the geographic distribution of each cancer type was evaluated separately to determine whether an atypical pattern of any one type occurred. For confidentiality reasons, maps of the location of individuals diagnosed with cancer cannot be provided in this report. However, as described below, review of this information did not reveal any unusual spatial patterns or geographic concentrations of diagnoses in Marlborough that could not be attributed to such factors as increased population density.

A. Leukemia

During 1982-2002, leukemia was elevated in five of the six CTs in Marlborough, with CT 3215 having a statistically significantly elevated rate. The spatial distribution of leukemia within the CTs was reviewed. A large number of individuals with leukemia in CT 3215 were located in or near the center of Marlborough. There is a direct correlation between population density and the geographic distribution of leukemia cases observed in this census tract. In addition, no specific concentration of cases by subtype was apparent among these individuals that would suggest a common environmental factor was related to their diagnosis. No unusual geographic patterns or concentrations of individuals with leukemia were observed in CT 3214 in the Glen Street neighborhood or near the former orchard area.

When evaluating leukemia in a geographic context, it is important to examine the location of cases by type of leukemia. The four main types of leukemia each have their own unique etiologies (or causes) and/or risk factors, some of which are understood better than others. As discussed previously, there are four main types of leukemia: CLL, ALL, AML, and CML. The most common type of leukemia diagnosed in Marlborough during 1982-2002 was AML, which represented 37% of all leukemia diagnoses (n=32). Again, the majority of individuals diagnosed with AML were located in or near the center of Marlborough, but no specific concentration of these individuals was evident. Overall there were ten (11%) individuals with CML in Marlborough during 1982-2002, distributed fairly evenly throughout the city. Of these, two resided in CT 3214, including one in the Glen Street neighborhood. None of the individuals with CML were located in close proximity to one another.

The second most common type of leukemia diagnosed in Marlborough during 1982-2002 was CLL (23%, n=20). A small concentration of approximately seven individuals diagnosed with CLL was observed in the center of Marlborough. In addition to higher population density in this area of the city, these individuals were diagnosed in different years, indicating that these cases were not concentrated over time, and all of the individuals were 65 or older, as expected for this type of leukemia. Individuals diagnosed with this type of leukemia who did not live near the center of the city (i.e., in CTs 3211, 3212, and 3214) were not located in close proximity to each other.

ALL is typically diagnosed among children and people of older age groups (i.e., age 50 and older). The majority of individuals diagnosed with ALL in Marlborough during 1982-2002 (ten children and two older adults) lived in and around the center of the city at the time of diagnosis. Again, this is a high-density residential area and the observed pattern of a greater number of cases in this area is not unexpected. Two children diagnosed with ALL during 1982-2002 were within close proximity of one another in CT 3214. These individuals did not reside near the Glen Street neighborhood and the dates of diagnosis for these individuals differed by more than six years.

During 1982-2002, there were 13 individuals (15%) with types of leukemia that could not be classified into one of the four major subtypes either because they were otherwise classified or classified as NOS. Although these leukemia types do not likely share a common etiology, individuals who were diagnosed as "other" were still reviewed geographically. The residence of these individuals did not exhibit any unusual geographic patterns within the city.

B. Liver Cancer

Of the 28 individuals diagnosed with liver cancer between 1982-2002 in Marlborough, the majority lived in or near the center of the city. In CT 3213, where a statistically significant elevation of liver cancer was observed, all nine of the individuals diagnosed were located in the northern portion of the census tract. This area of CT 3213 is more densely populated and has a number of multi-unit housing complexes, where some individuals resided at the time of diagnosis, and likely contributes to the great number of cases in this area of the census tract. The dates of diagnosis for these individuals varied throughout the 21-year time period, indicating no temporal pattern of diagnoses over time and seven of the nine individuals were over the age of 70. In CT 3214, one person was diagnosed with liver cancer. The individual resided in the northern portion of the census tract, which is not located near the former orchard property or the Glen Street neighborhood. No other geographic concentrations of liver cancer diagnoses were observed during the 1982-2002 time period.

C. Lung Cancer

No unusual geographic pattern of lung cancer was observed in the city of Marlborough or within any of the six census tracts during the 21-year time period evaluated 1982-2002. In census tracts where cases appeared to be geographically concentrated, further evaluation showed that the concentrations were located in areas of dense population or were likely explained by the presence of multi-unit housing complexes. No unusual geographic pattern of lung cancer was observed within CT 3214 or near the Glen Street neighborhood and/or the former orchard area. Finally, review of non-smokers diagnosed with lung cancer revealed no apparent spatial concentrations of cases.

VIII. CANCER INCIDENCE IN THE GLEN STREET NEIGHBORHOOD

To address concerns over a suspected elevation of cancer in the Glen Street neighborhood in Marlborough, MA (see Figure 2), a review of MCR data for residents of this area who had been diagnosed with any cancer type since 1982 was conducted. In general, our review found no atypical pattern of cancer in the Glen Street neighborhood. Between 1982 and the present (as of May 12, 2006), a total of 50 cancer diagnoses were reported to the MCR among 45 residents of the Glen Street area roughly bounded by Glen Street and MacKay Drive to the west, Interstate 495 to the east, Forest Street to the south, and Mount Royal Avenue to the north (some individuals had more than one cancer diagnosis). Eighteen different types of cancer were diagnosed among residents, indicating the occurrence of many different diseases. The most commonly reported diagnoses included cancers of the lung and bronchus, breast, prostate, and colon/rectum, which is consistent with national and statewide trends in cancer incidence. Together, these cancer types represented more than half (56%) of the cancer diagnoses in this area. Other types of cancer included bladder cancer, kidney cancer, multiple myeloma, laryngeal cancer, oral cavity and pharynx cancer, brain and central nervous system (CNS) cancer, leukemia, melanoma, cervical cancer, ovarian cancer and other rare types. There was no specific temporal pattern or geographic concentration of any one cancer type. That is, diagnoses did not appear "clustered" in time or space within the Glen Street neighborhood. The years of diagnosis for these individuals varied throughout the 22 years reviewed.

The majority of cancer types diagnosed among residents of the Glen Street neighborhood are predominantly associated with non-environmental factors such as family history, smoking, diet, and other lifestyle behaviors. Because the MCR collects some information related to risk factors (e.g., smoking history) for individuals diagnosed with cancer, to better characterize the incidence patterns of cancer in this area of Marlborough, the available data on risk factors from the MCR for individuals diagnosed with cancer in the Glen Street neighborhood was reviewed (e.g., age at diagnosis, gender, smoking history, and occupation).

Age is an important risk factor in many cancers. Different cancers occur with different frequencies among the various age groups, and most cancer types occur more frequently in older populations (i.e., age 50 and over). The average age at diagnosis among individuals in the Glen Street neighborhood was 61 and the majority of diagnoses (86%) occurred among individuals aged 50 or older at the time of diagnosis. Half of the individuals were male (n=25). Review of information regarding age and gender indicates that the incidence of cancer in this area is generally consistent with established prevalence patterns of disease in the general population.

Because cigarette smoking is an important risk factor in the development of several cancer types, including cancers of the lung and bronchus, oral cavity and pharynx, larynx, bladder, kidney, and colon/rectum, smoking history was also reviewed for each individual in the Glen Street neighborhood who had been diagnosed with these diseases. Of the 24 individuals with a smoking-related cancer, 19 (79%) reported being current or

former smokers at the time of diagnosis, four were non-smokers, and smoking history was unknown for one individual. Therefore, it is likely that smoking played an important role in the development of cancer among some residents of the Glen Street neighborhood.

Finally, some occupational exposures, such as in jobs involving contact with chemicals, have also been associated with an increased risk for developing certain types of cancer. While the MCR data available for occupation are limited (i.e., the occupation is often listed too generally as the name of a business or as retired), a review of occupation as reported to the MCR was conducted. Review of this information showed that one individual in this area of Marlborough worked in a job where exposures that could be related to an increased risk for developing their cancer may have been possible. None of the information available for any other residents diagnosed with cancer suggested that exposures at work were likely related to their development of cancer. It is probably also important to mention that the information reported to the MCR is based on occupation at the time of diagnosis and therefore potential exposures associated with past occupations cannot be determined. Occupation was reported as retired, at home, or unknown for 25% of the individuals diagnosed with cancer in the Glen Street neighborhood.

IX. COMMUNITY ENVIRONMENTAL CONCERNS

In addition to reviewing environmental data for the former apple orchard in Marlborough, discussed separately in the Public Health Assessments (MDPH 2000; MDPH 2006), information regarding other potential environmental sources located in Marlborough and listed with the Massachusetts Department of Environmental Protection (MDEP) was reviewed (MDEP 2001a, 2001b, and 2002a). Under Chapter 21E of the Massachusetts General Laws (also known as the State Superfund), which was enacted in 1983, the MDEP investigates potentially hazardous waste sites in the state and conducts and oversees cleanup of these sites. The locations of sites in the BWSC database were mapped and evaluated in relation to the places of residence of individuals diagnosed with cancer in Marlborough between 1982 and 2002.

Although the Massachusetts General Laws require that MDEP be notified of contamination that exceeds specified levels, it is important to note that chemical concentrations detected in environmental media do not necessarily represent a health threat. In order for a compound to impact one's health, it must not only be present in a certain environmental media but one must also come into contact with the compound via the contaminated media (e.g., through ingestion, inhalation, or skin absorption). Therefore, the presence of contaminants at a site alone does not necessarily indicate a potential health impact to nearby residents. However, the pattern of individuals diagnosed with leukemia, liver cancer, and lung cancer in Marlborough in proximity to these sites may indicate that an environmental factor could be related to the incidence of these cancer types in Marlborough.

A summary of the 21E sites in Marlborough reported to MDEP from 1983 to 2002 is presented in Table 17. A total of 353 environmental releases or spills have been reported to MDEP under the State Superfund program. However, as shown in Table 17,

multiple releases were reported at some sites. Approximately 22% (n=77) of sites reported to MDEP during this time period did not have sufficient address information to allow for mapping of the site location. Of all the reported releases during this time period, 60% involved petroleum-related chemicals (e.g., oils, fuels, gasoline), 25% of sites involved other chemicals (e.g., metals, organic compounds, pesticides), and the type of material was unknown for 15% of the releases.

X. DISCUSSION

While statistically significant elevations were noted in the incidence of leukemia, liver cancer, and lung cancer during the period 1982-2002 in the city of Marlborough and in some individual census tracts, these elevations did not persist into the most recent time period (1999-2002) for any of the cancer types investigated, which all occurred about as expected for the city as a whole. Review of available risk factor information from the MCR for individuals diagnosed with these cancer types in Marlborough suggests that the patterns of these three cancers with respect to age and gender are consistent with trends in the general population. It also appears that smoking likely played an important role in the incidence of lung cancer in Marlborough during 1982-2002 (93% of those with a known smoking history were current or former smokers). In addition, it is possible that occupational exposures may have contributed to the development of leukemia and lung cancer among some individuals in Marlborough.

Childhood leukemia was also statistically significantly elevated among males in Marlborough during 1982-2002. When evaluating childhood cancer during 1982-2002, all male children were diagnosed with the most common type for children (ALL) and the geographic distribution of individuals did not indicate an unusual pattern (i.e., diagnoses spread throughout five of the six CTs of Marlborough). Also, a review of residential history indicated that four of the nine children likely had recently moved to Marlborough, suggesting that residence in Marlborough was not likely to have played a role in their diagnosis. The 11 diagnoses of leukemia among children were also spread over the entire time period with no temporal concentration within Marlborough. Thus, all their information together does not suggest a common factor, environmental or otherwise, played a role in these childhood leukemia diagnoses.

Analysis of the geographic distribution of residences of individuals diagnosed with leukemia, liver cancer, or lung cancer during 1982-2002 did not reveal any atypical spatial patterns of cancer. Specifically, the distribution of diagnoses seemed to coincide closely with the pattern of the population in Marlborough. Additionally, because members of the community had voiced particular concerns regarding the Glen Street neighborhood and the former apple orchard area (both located in CT 3214), the pattern of cancer incidence for this area was specifically reviewed. In CT 3214 between 1982-2002, leukemia and cancers of the lung and liver occurred approximately at expected rates when compared to statewide incidences for those cancer types. A review of the geographic distribution of individuals diagnosed with these cancer types did not reveal any unexpected spatial patterns or other concentration of diagnoses in CT 3214 near or in

the Glen Street neighborhood or near the former apple orchard property during the 21-year time period evaluated 1982-2002.

Finally, several chemical contaminants (i.e., pesticides) were detected at the former apple orchard, some of which have been associated with an increased risk of liver cancer (i.e., arsenic, DDT, and dieldrin) and lung cancer (i.e., arsenic). However, it is unlikely that exposure to these compounds by residents of the Glen Street neighborhood or the surrounding area would have resulted in adverse health effects (including cancer) based on the concentrations detected and estimated exposure opportunities (MDPH 2000). As discussed above, the incidence of leukemia, liver cancer, and lung cancer was about as expected in CT 3214 between 1982-2002 and no unusual concentrations of diagnoses were observed in the area surrounding the former orchard or any other part of the census tract, lending further support to the conclusion that environmental factors were not likely to have played a major role in the pattern of these cancer types in this area of Marlborough.

XI. LIMITATIONS

This investigation considers descriptive health outcome data for cancer to determine whether the pattern or occurrence of selected cancers is unusual. The purpose of this investigation was to evaluate the patterns of cancer in a geographical context in relation to available information about factors, including environmental factors, related to cancer to see whether further investigation seems warranted. Information from descriptive analyses, which may suggest that a common etiology (or cause) is possible, can serve to identify areas where further public health actions may be warranted. Inherent limitations in this type of analysis and the available data make it impossible to determine the precise causal relationships or synergistic roles that may have played a part in the development of individual cancers in this community. Also, this type of analysis cannot determine what may have caused cancer in any one individual. Cancers in general have a variety of risk factors known or suggested to be related to the etiology (cause) of the disease that could not be evaluated in this report. It is believed that many types of cancers are related largely to behavioral factors such as cigarette smoking, diet, and alcohol consumption. Other factors associated with cancer are socioeconomic status, heredity/genetics, race, and geography. It is beyond the scope of this report to determine the causal relationship of these factors and the development of cancer or other health outcomes in Marlborough.

XII. CONCLUSIONS

- Review of the available case information, environmental data, and geographic pattern of diagnoses does not suggest that a common factor (environmental or non-environmental) is likely related to these diagnoses.

- With respect to the Glen Street area and surrounding orchard property, there were no unusual patterns of cancer observed. During the 21-year time period 1982-2002, one

individual was diagnosed with liver cancer in CT 3214, where Glen Street is located; however, this individual did not reside near the area of concern. During the time period 1982-2002, leukemia and lung cancer both occurred at about the levels expected in CT 3214, and neither of these cancer types was unusually concentrated anywhere within this census tract.

- Leukemia was statistically significantly elevated citywide in Marlborough and in CT 3215 during 1982-2002. Leukemia diagnoses in Marlborough were of all different subtypes and review of the histology distribution did not reveal any atypical or unexpected patterns. The majority of individuals with leukemia in Marlborough were located close to the center of Marlborough, which is the most densely populated area in the city. No unusual patterns were observed when leukemia was evaluated by subtype with respect to geographic location. In addition, diagnoses of leukemia were spread across the 1982-2002 period with no increasing or decreasing trend.

- Although the rate of childhood leukemia among males was statistically significantly elevated in Marlborough during the 1982-2002 time period evaluated, available information on histology, geographic distribution, temporal distribution, and residential history does not suggest a common factor played an important role in this elevation.

- Review of available risk factor information related to lung cancer incidence in the city of Marlborough between 1982-2002 suggests that cigarette smoking likely played a role in the statistically significantly elevated rate of lung cancer citywide.

- The information reviewed indicates that occupational exposures may have been a potential factor in the development of leukemia and lung cancer among some individuals during the 21-year time period 1982-2002. However, information on occupation reported to the MCR is generally too limited to evaluate the actual role it may have played in areas where increased leukemia and lung cancer rates were observed.

- Review of MCR data for residents of the Glen Street neighborhood diagnosed with any cancer type between 1982 and the present revealed no atypical pattern of cancer in this area. Eighteen different types of cancer were diagnosed among residents of this neighborhood, indicating the occurrence of many different diseases. In general, the patterns observed were consistent with national and statewide trends in cancer incidence.

XIII. RECOMMENDATIONS

- Although elevations were noted in the incidence of leukemia, liver and lung cancer in Marlborough during 1982-2002, based on the information reviewed, no specific pattern of these cancers emerged that suggests a common environmental factor is likely related to the incidence of these cancers. Therefore, the MDPH recommends no further investigation of cancer in Marlborough at this time. The MDPH/CEH will

continue to monitor the incidence of leukemia, liver cancer, and lung cancer in Marlborough through the city/town cancer incidence reports published by the Massachusetts Cancer Registry.

- If requested, the CEH's Environmental Health Education Program will work with the Marlborough Board of Health and the community to provide educational information and conduct outreach activities to Marlborough residents about ways to reduce their risk of cancer.

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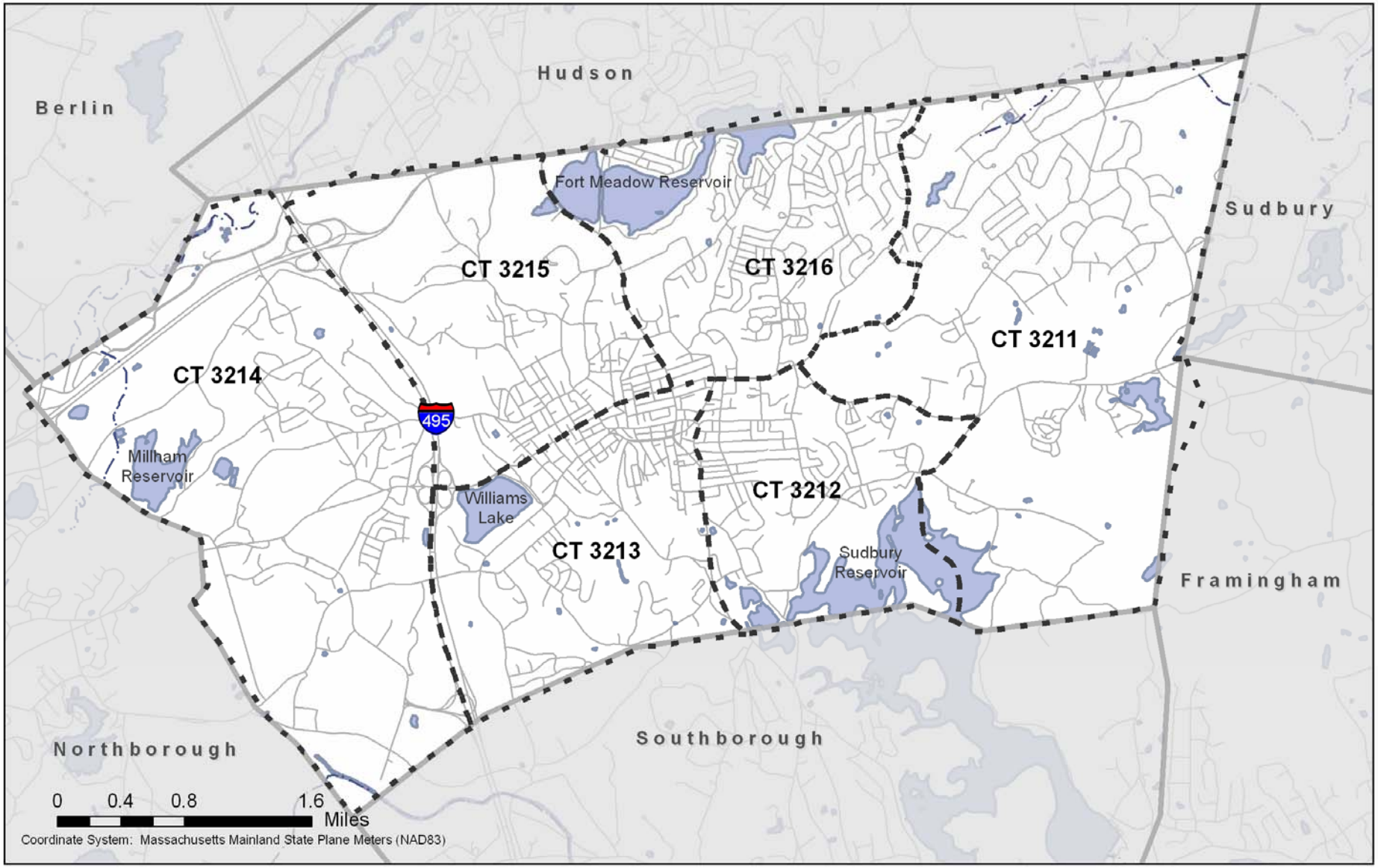
FIGURES

Figure 1
Location of Census Tracts in Marlborough, Massachusetts

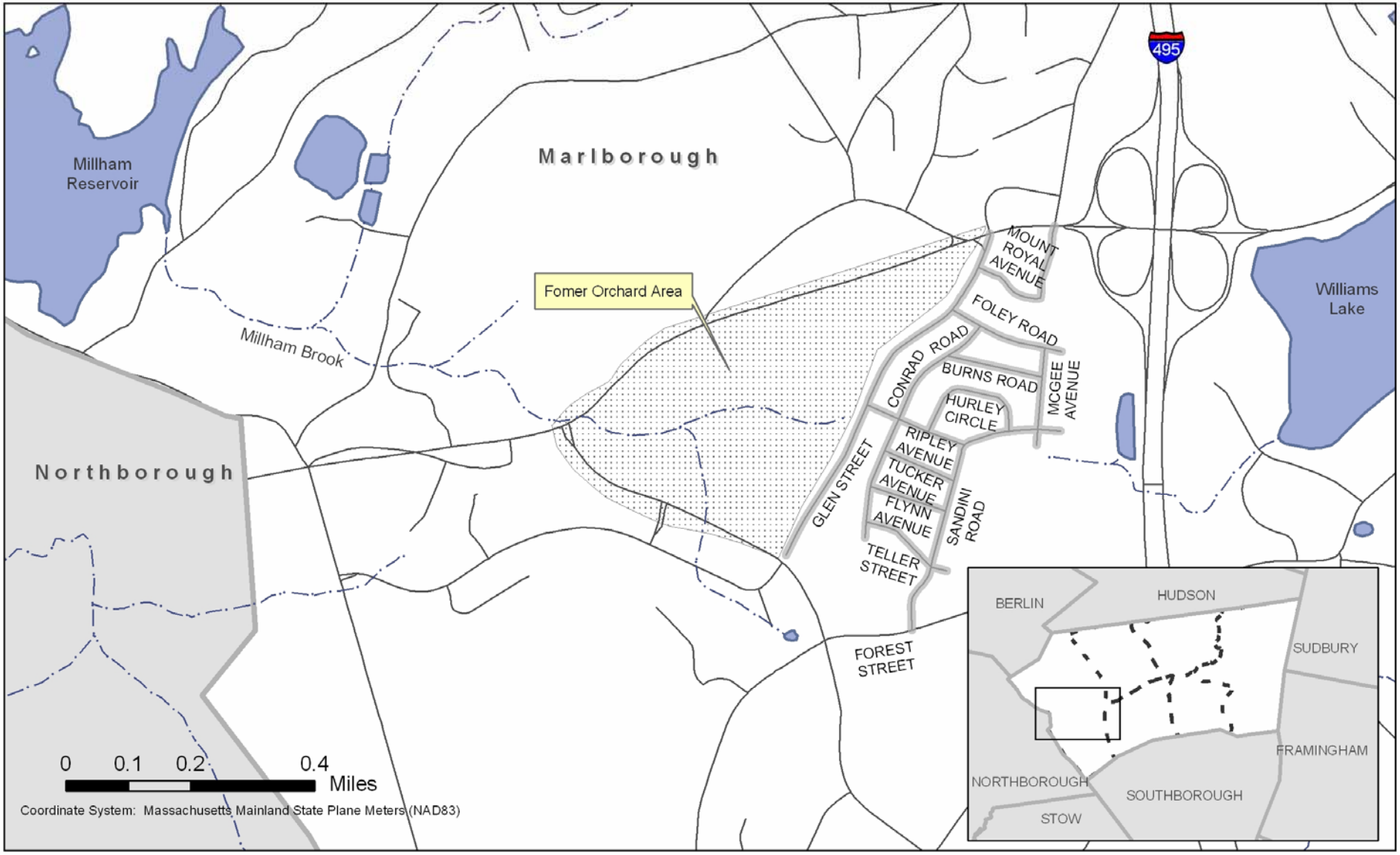


Center for CEH Environmental Health

Geographic data supplied by:
Massachusetts Executive Office of Environmental Affairs, MassGIS;
Geographic Data Technology, Inc.; U.S. Bureau of the Census.

Legend
- Major or minor road
- 2000 Census tracts
- Stream or brook
- Reservoir, lake or pond
- Marlborough
- Other town

Figure 2
Former orchard area and Glen Street neighborhood in Marlborough, Massachusetts



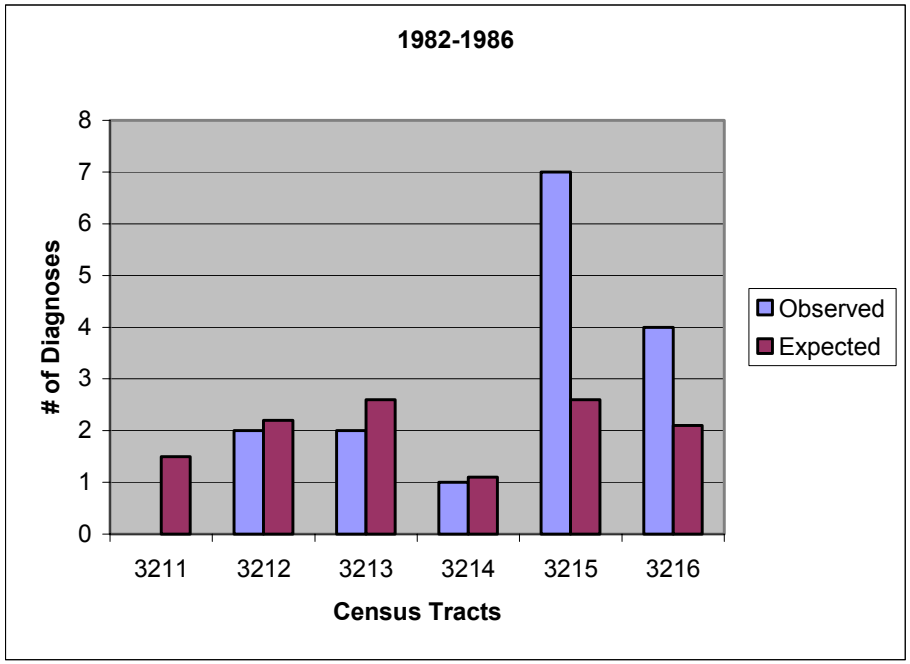
Center for CEH Environmental Health

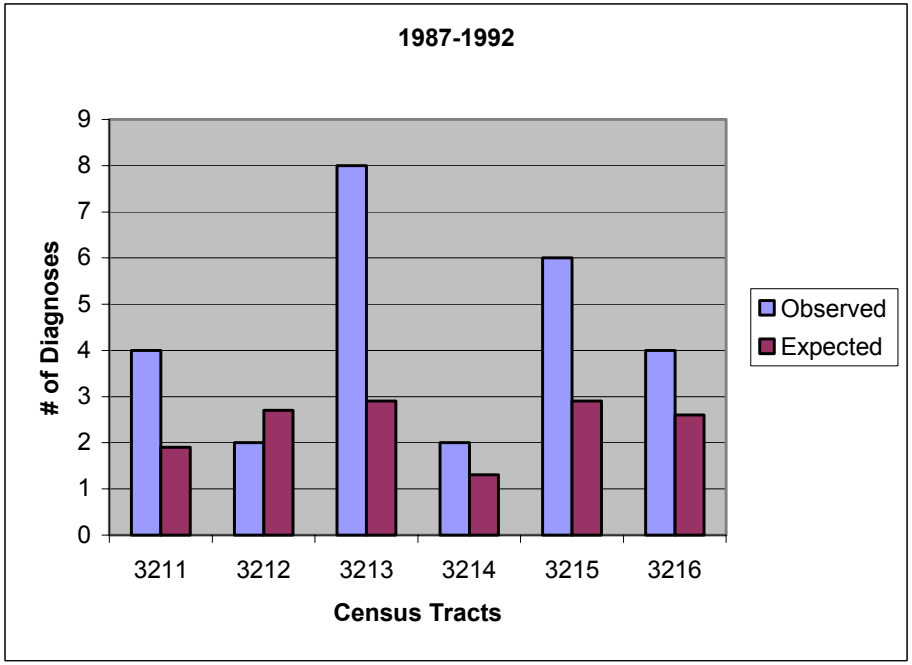
Geographic data supplied by:
Massachusetts Executive Office of Environmental Affairs, MassGIS;
Geographic Data Technology, Inc.; U.S. Bureau of the Census.

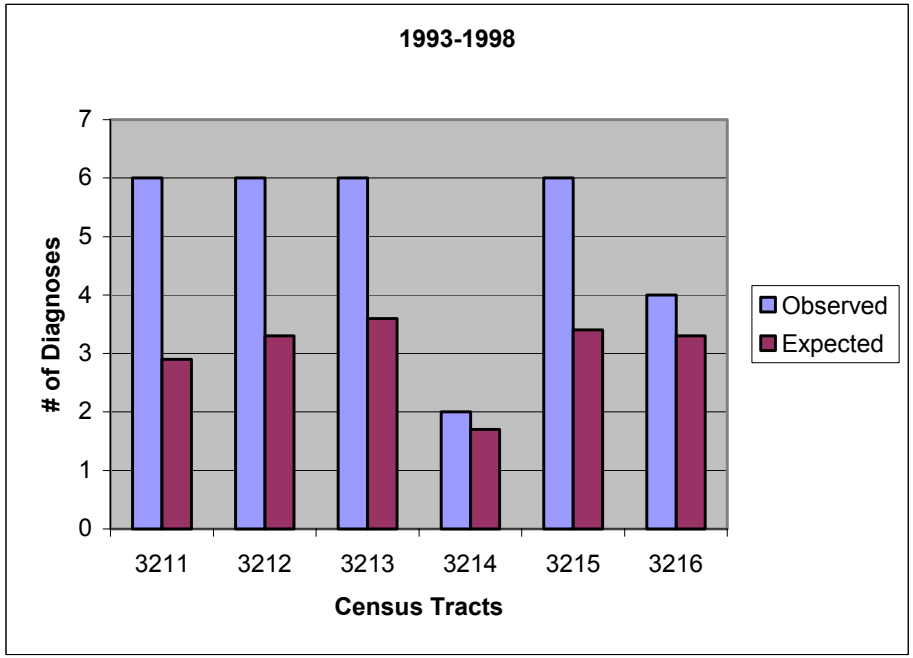
Legend

- Major or minor road
- Selected street
- Stream or brook
- Former orchard area
- Reservoir, lake or pond
- 2000 Census Tract
- Marlborough
- Other town

Figure 3: Incidence of Leukemia Diagnoses in Marlborough Census Tracts







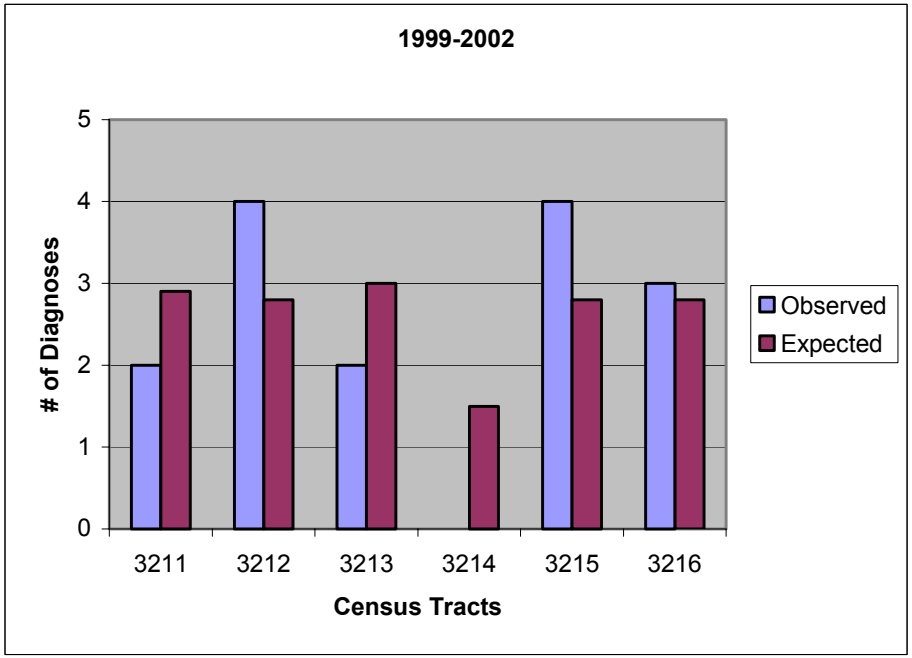
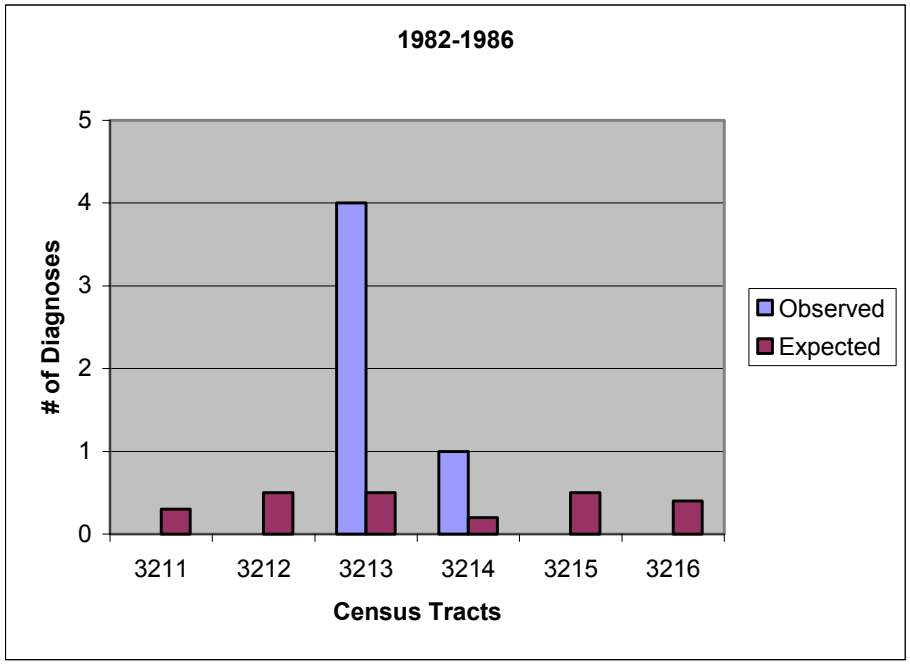
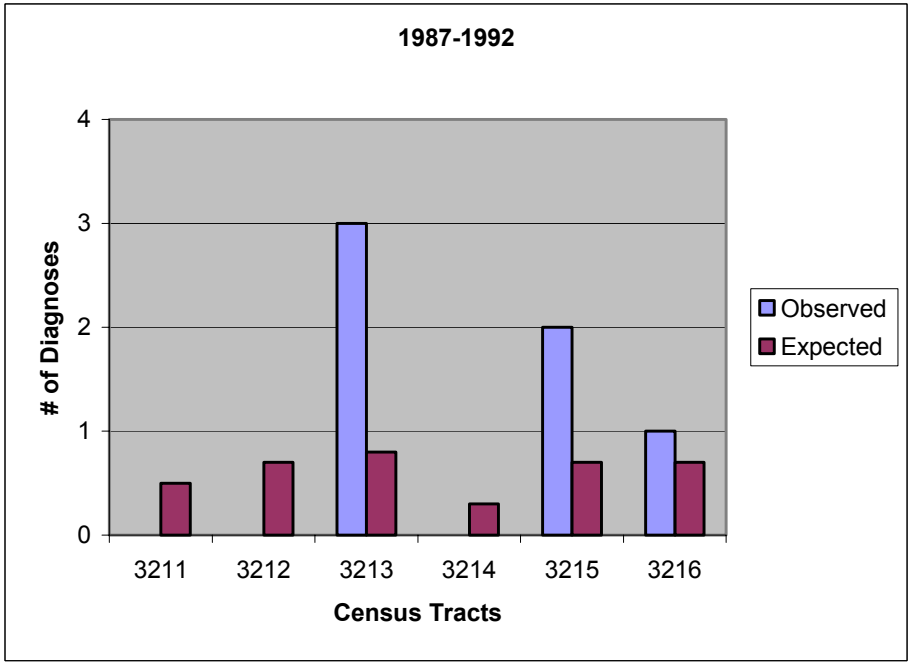
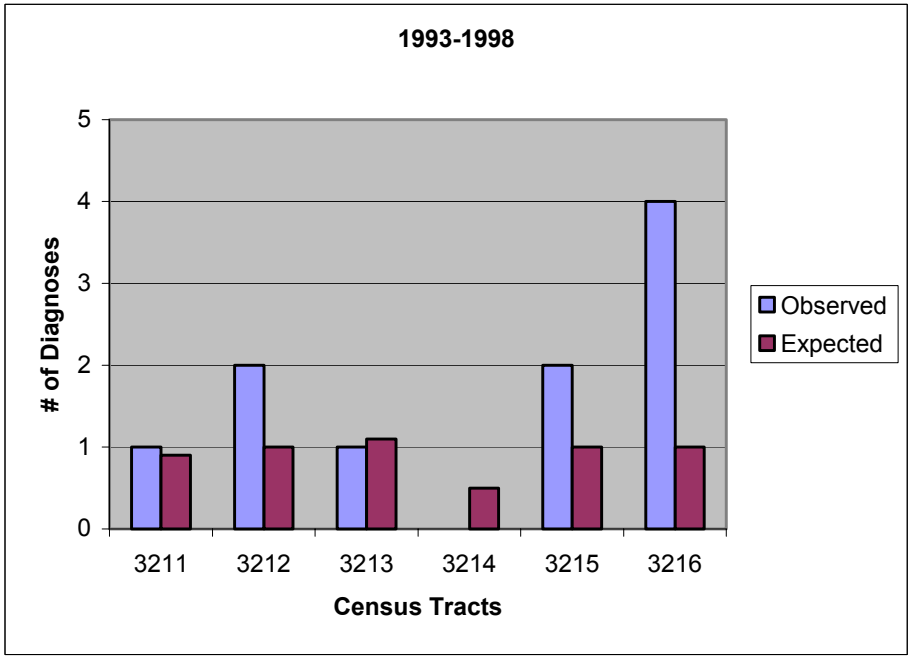


Figure 4: Incidence of Liver Cancer Diagnoses in Marlborough Census Tracts







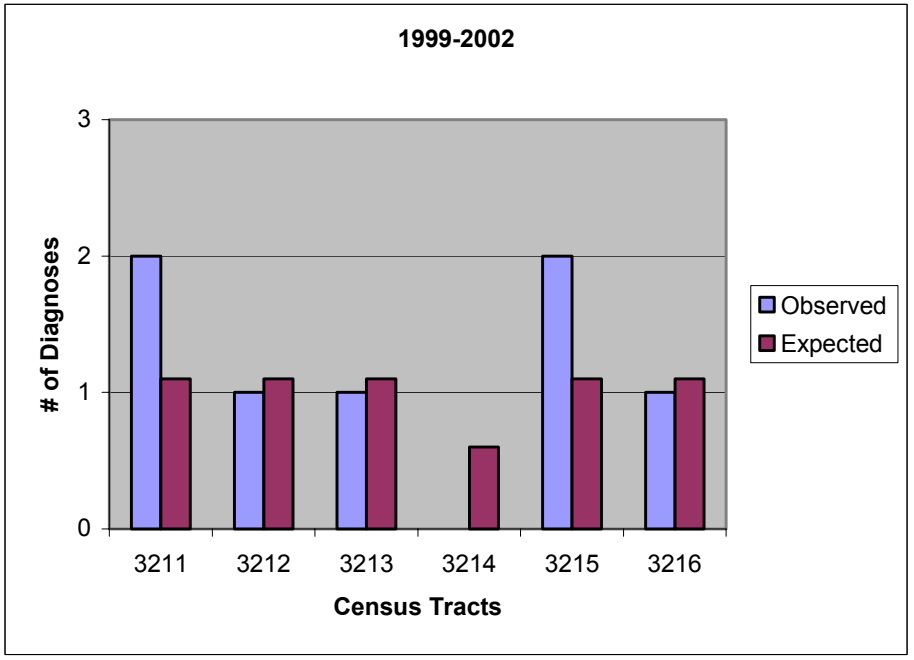
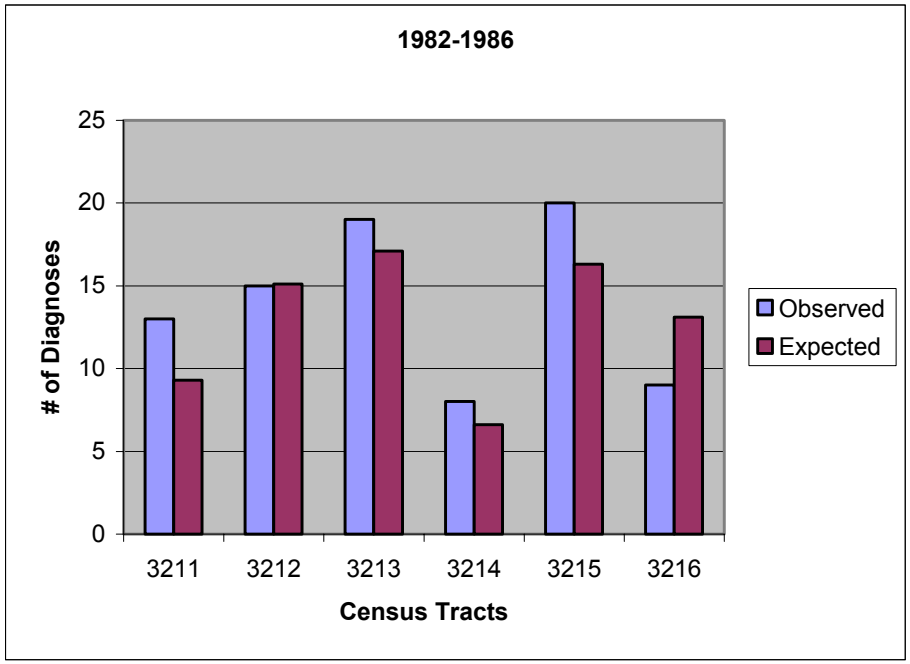
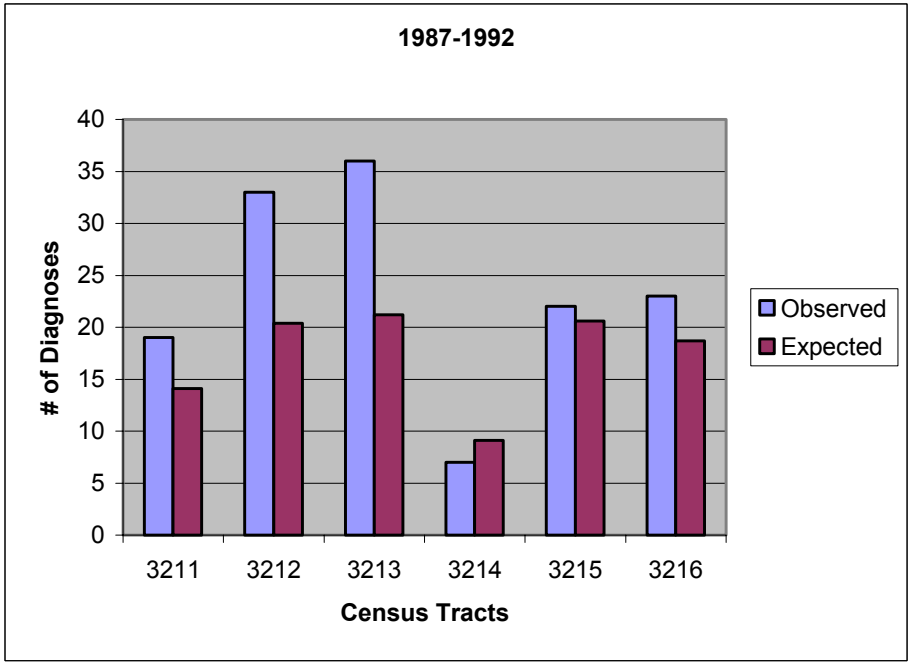
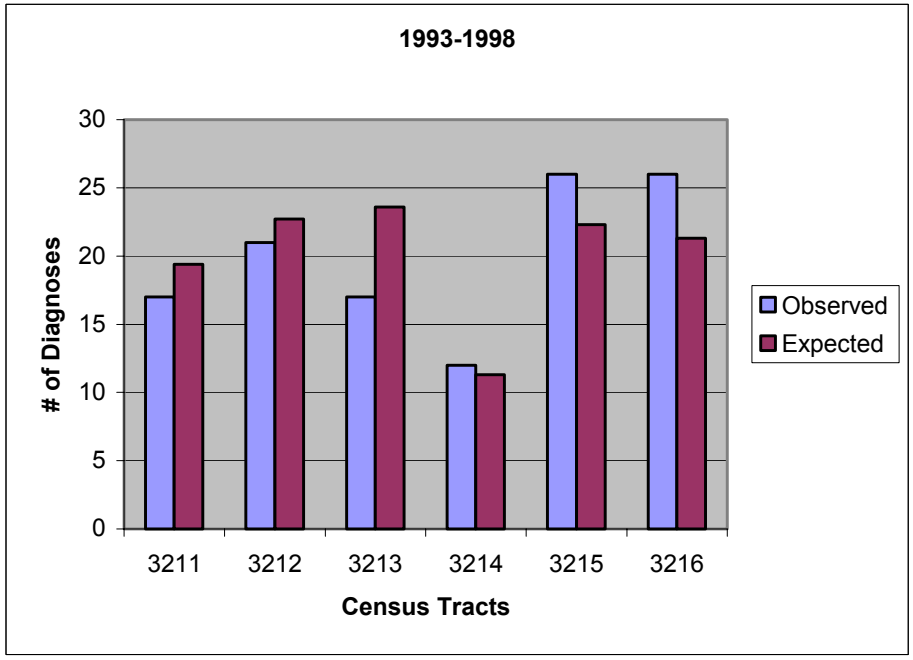


Figure 5: Incidence of Lung Cancer Diagnoses in Marlborough Census Tracts







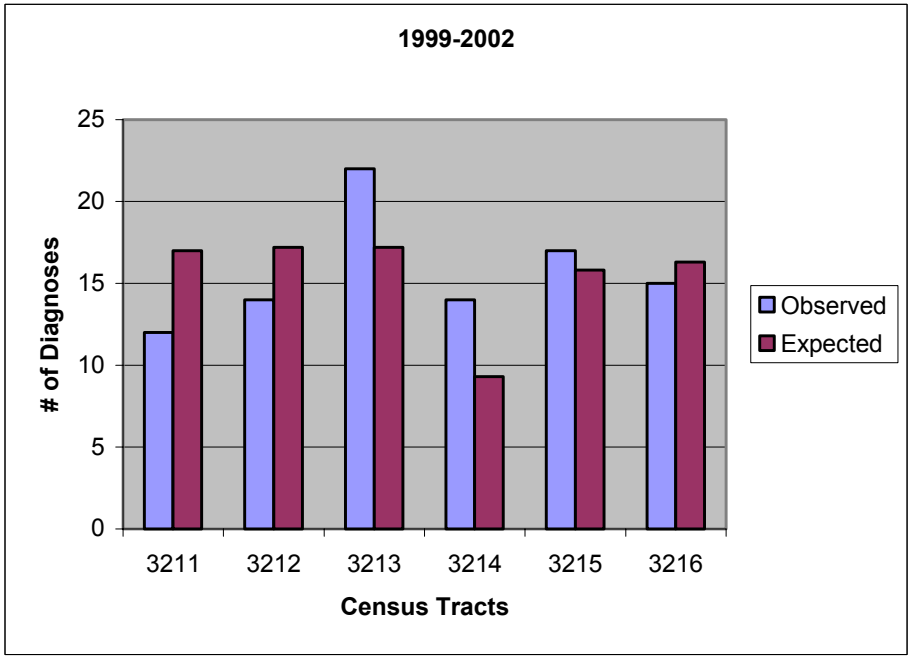


Figure 6
Distribution of Leukemia Subtype Among Individuals Diagnosed with Leukemia
Marlborough, MA
1982-2002

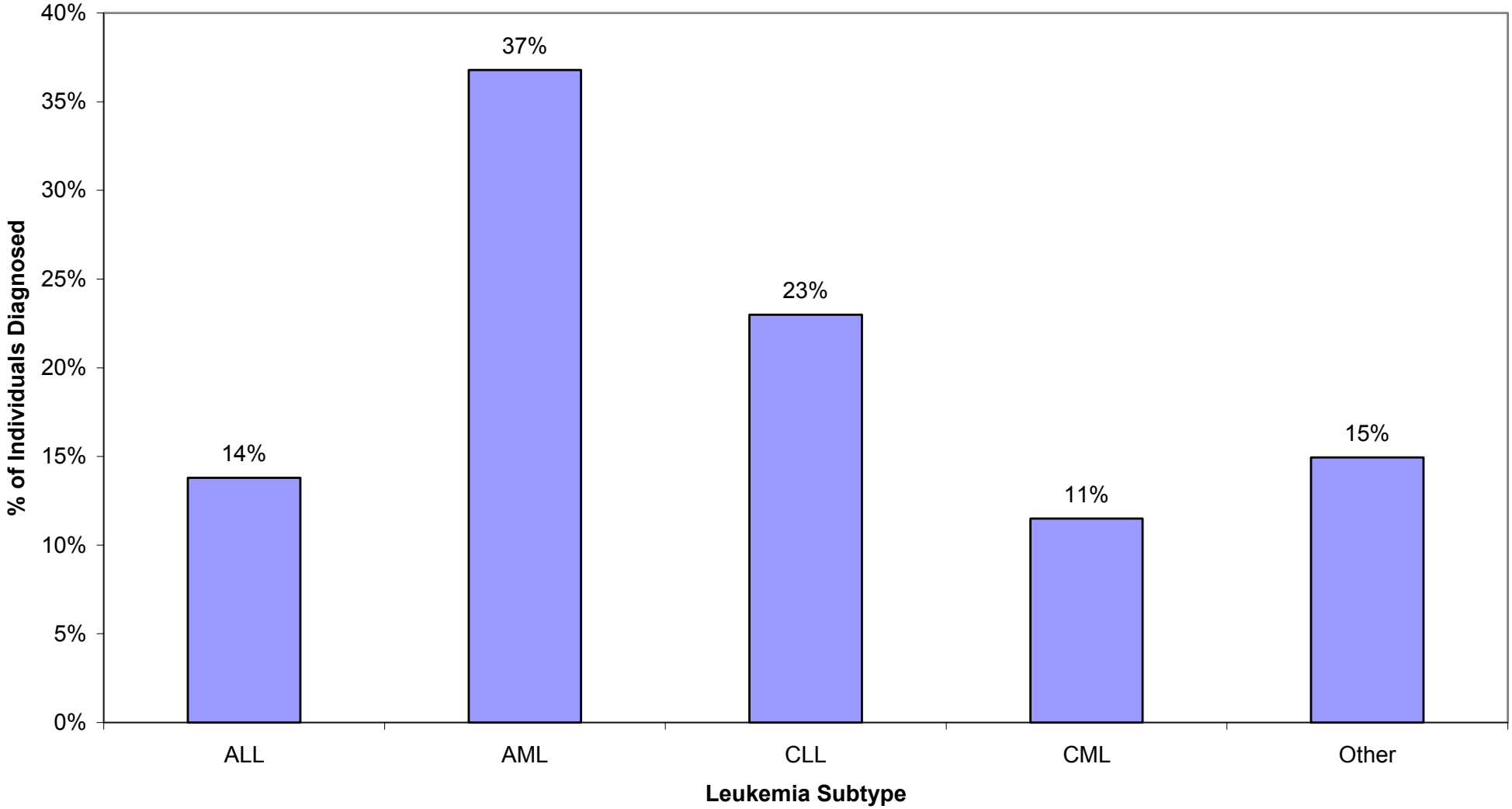


Figure 7
Distribution of Leukemia Subtype Among Individuals Diagnosed with Leukemia
Marlborough, MA
1982-1986

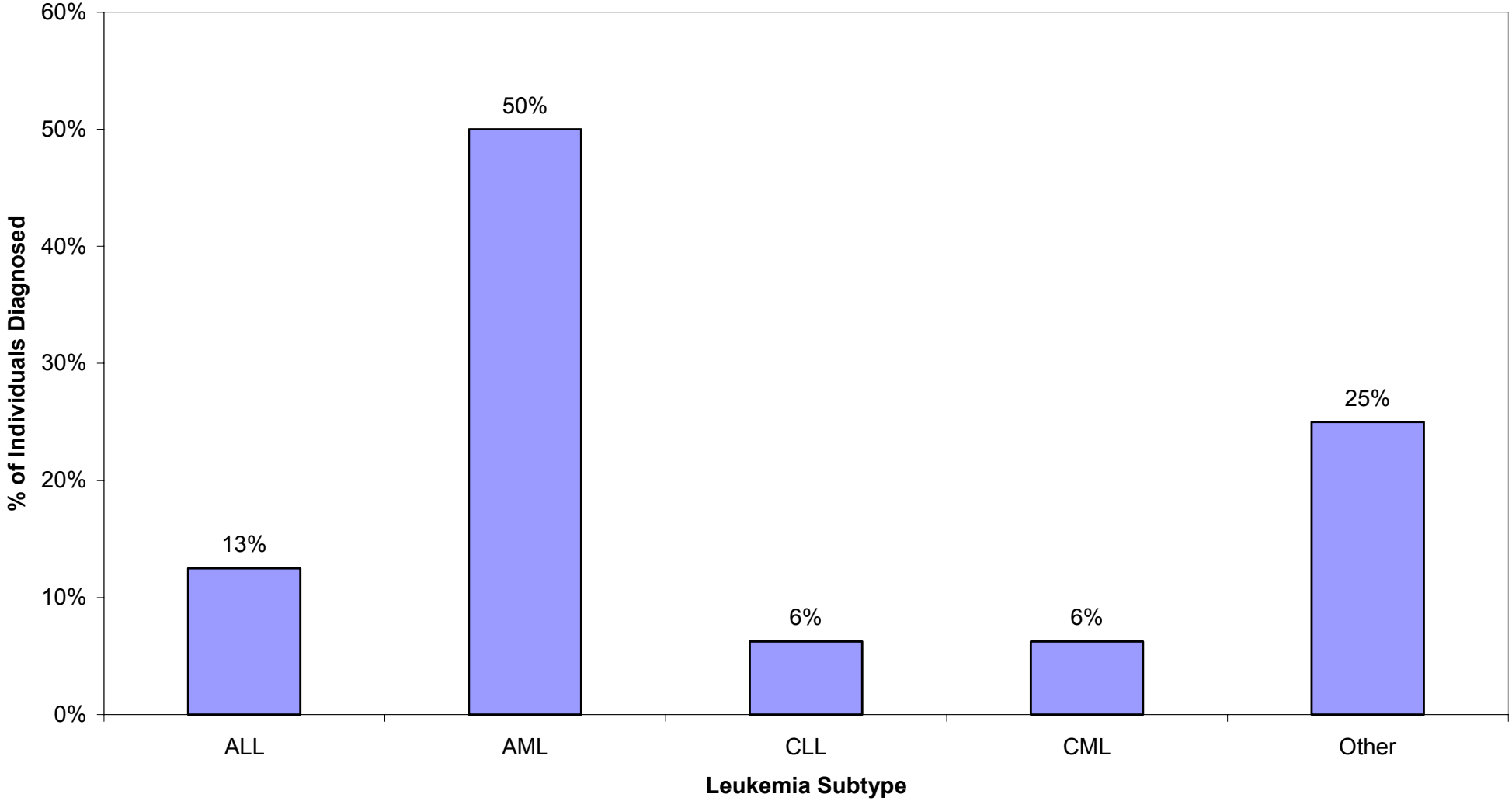


Figure 8
Distribution of Leukemia Subtype Among Individuals Diagnosed with Leukemia
Marlborough, MA
1987-1992

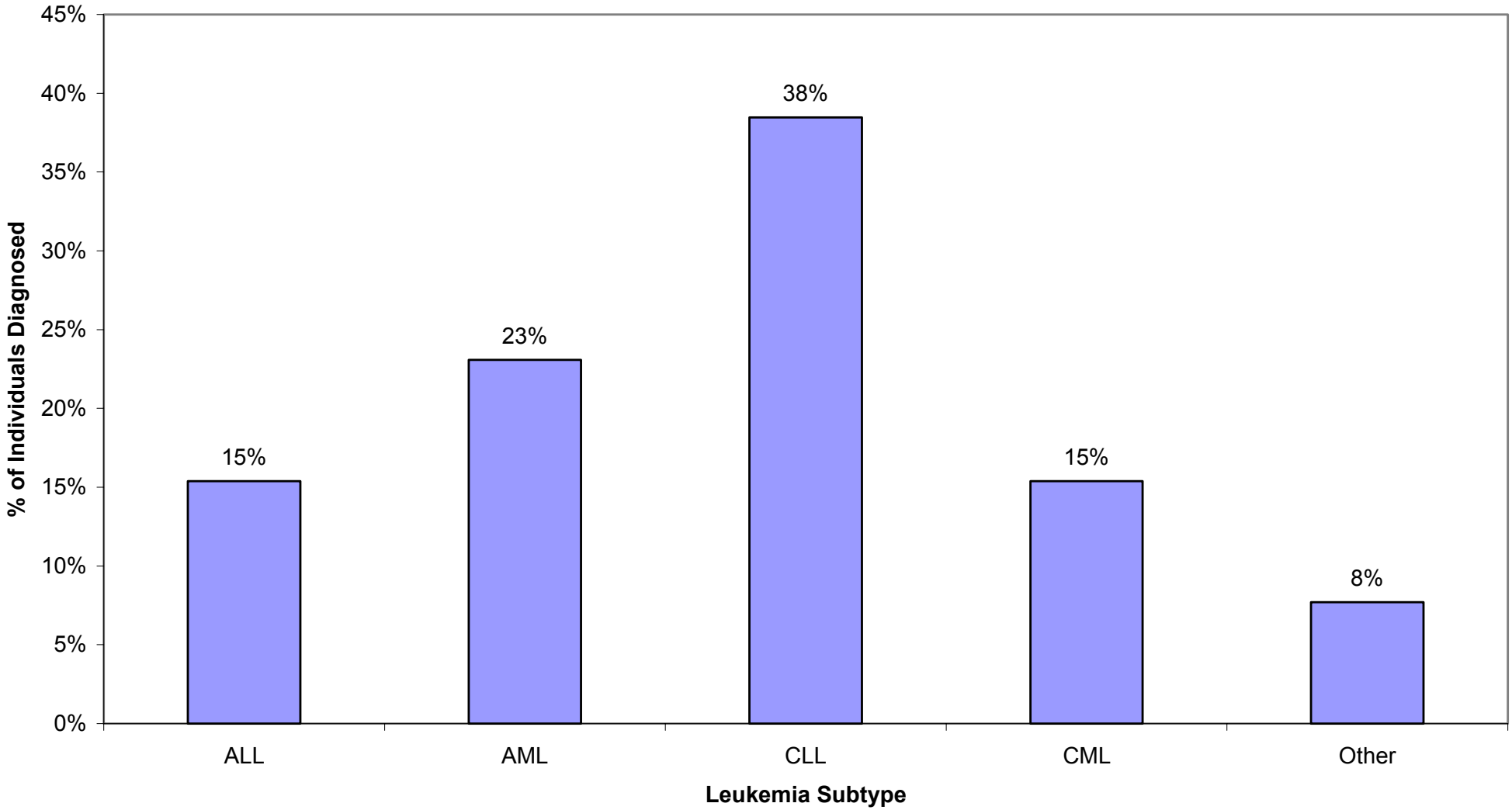


Figure 9
Distribution of Leukemia Subtype Among Individuals Diagnosed with Leukemia
Marlborough, MA
1993-1998

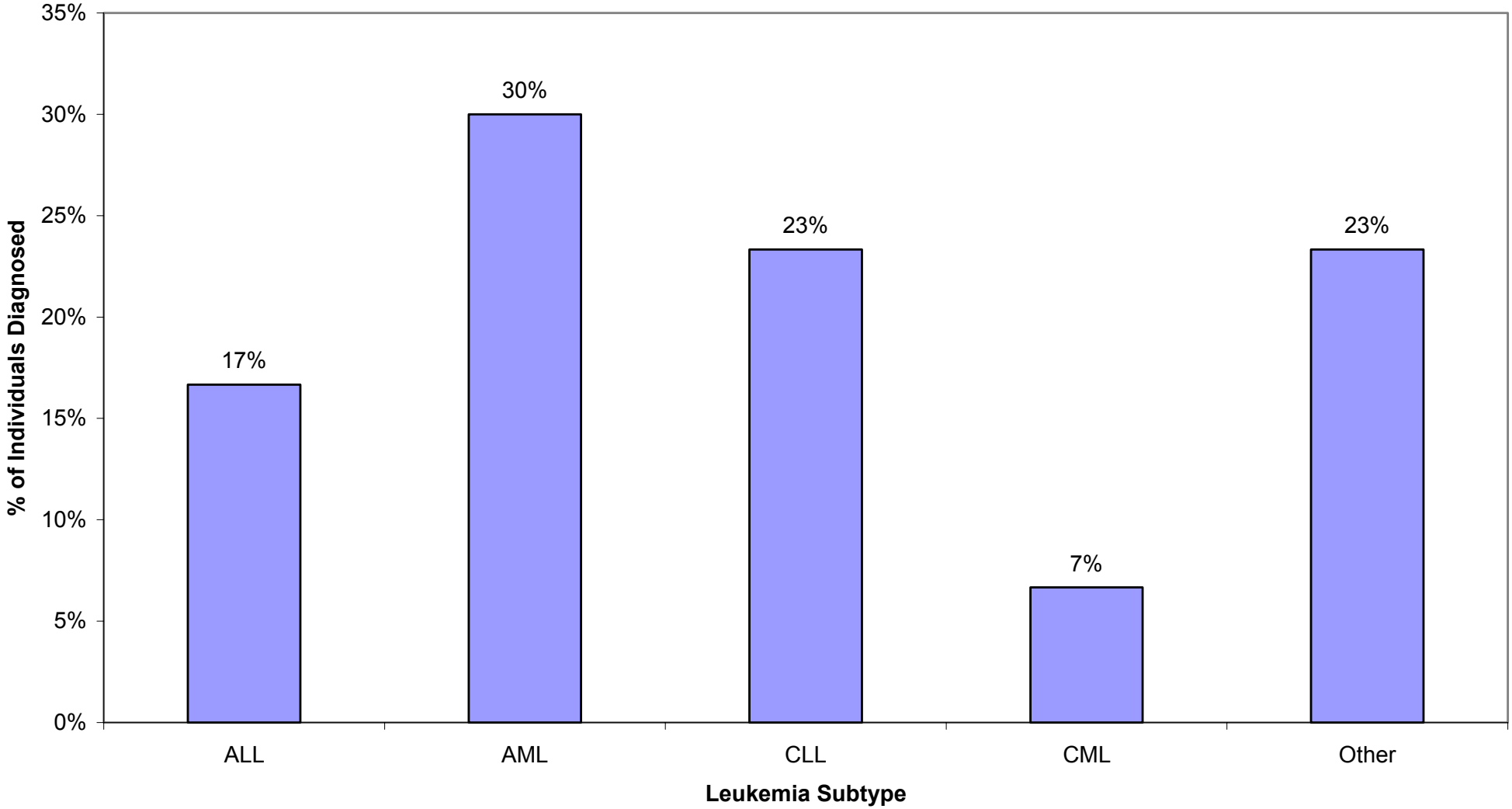


Figure 10
Distribution of Leukemia Subtype Among Individuals Diagnosed with Leukemia
Marlborough, MA
1999-2002

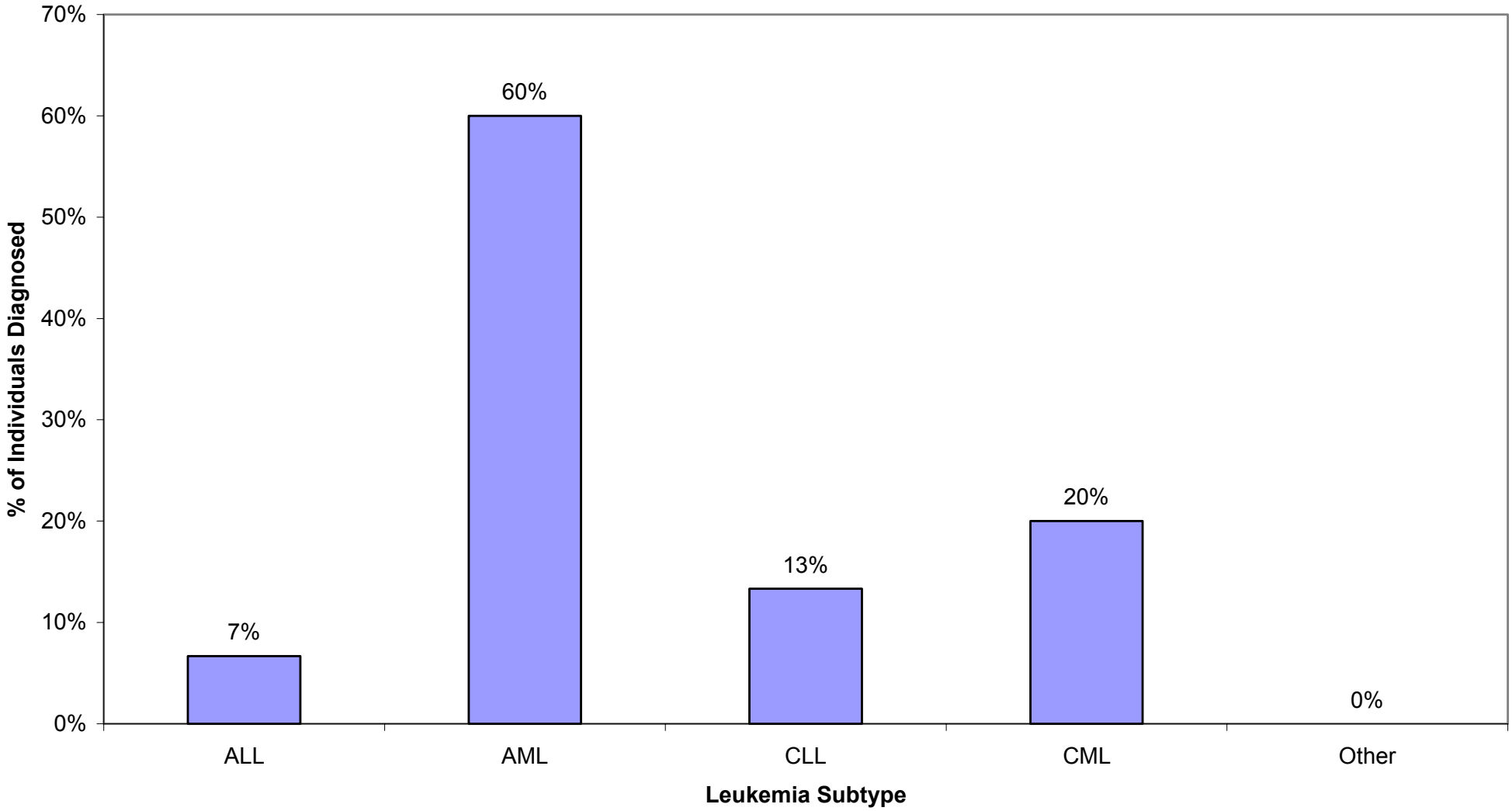


Figure 11
Distribution of Year of Diagnosis Among Individuals Diagnosed with Leukemia
Marlborough, MA
1982-2002

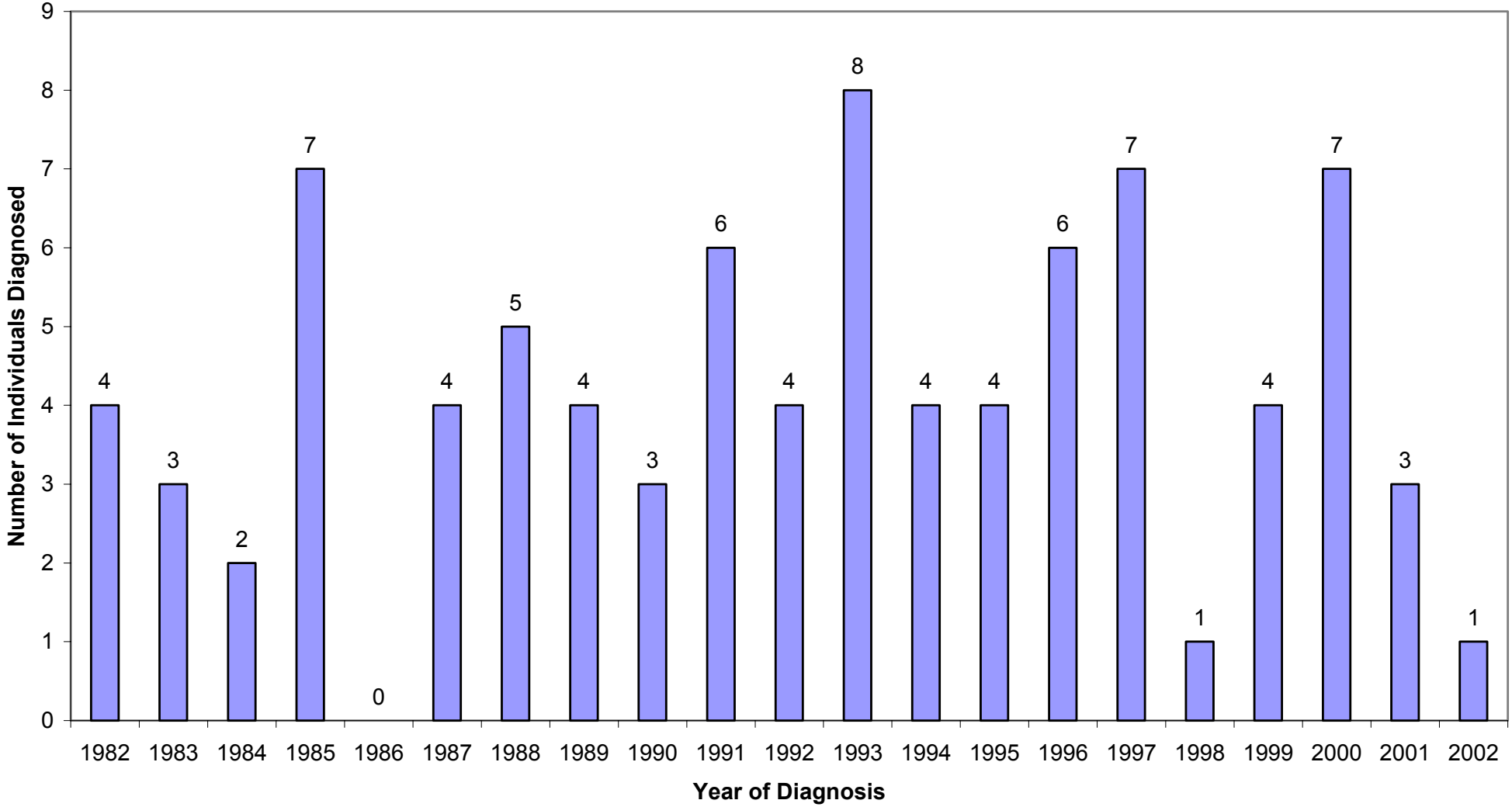


Figure 12
Smoking History Among Individuals Diagnosed with Lung Cancer in Marlborough, MA
1982-2002

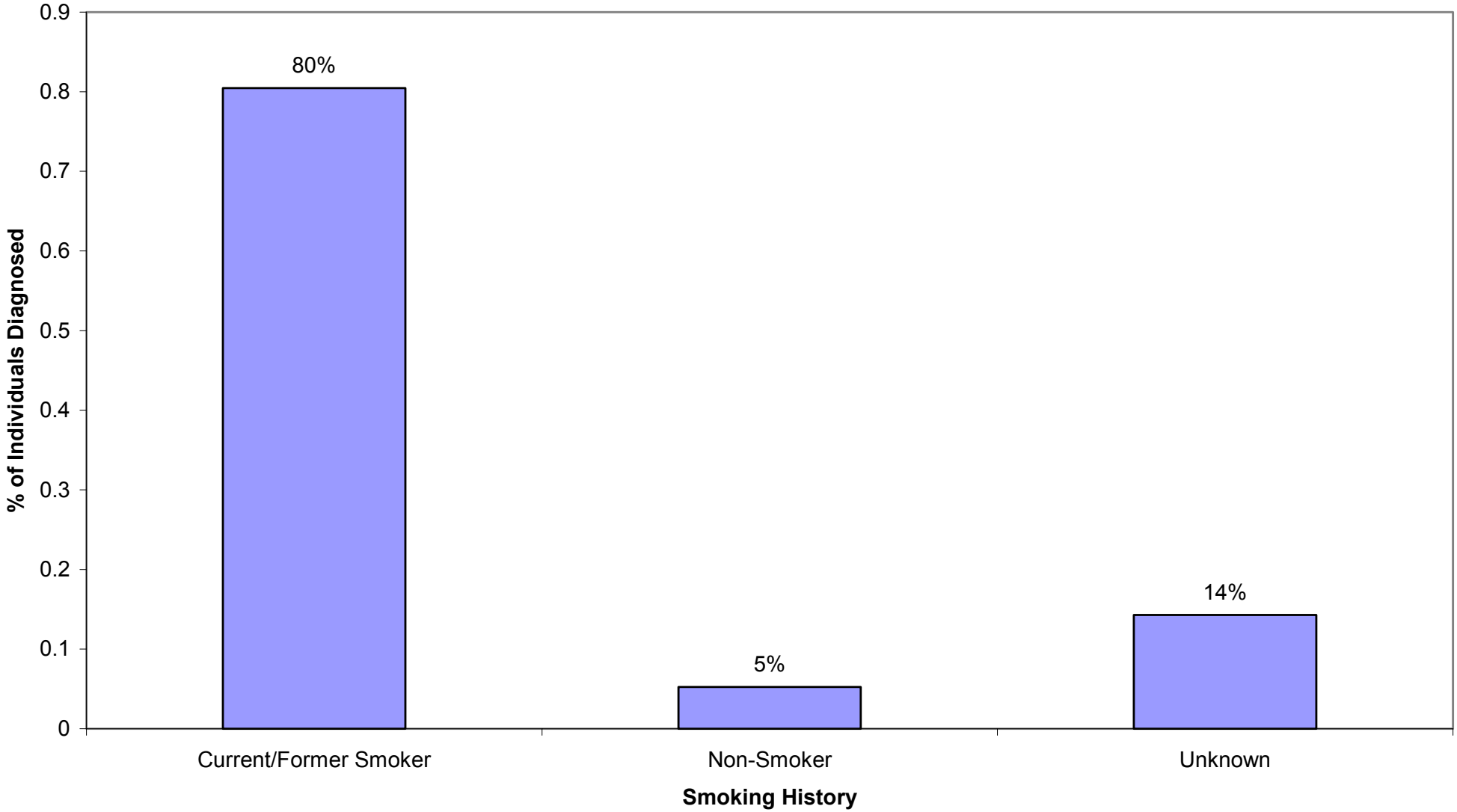
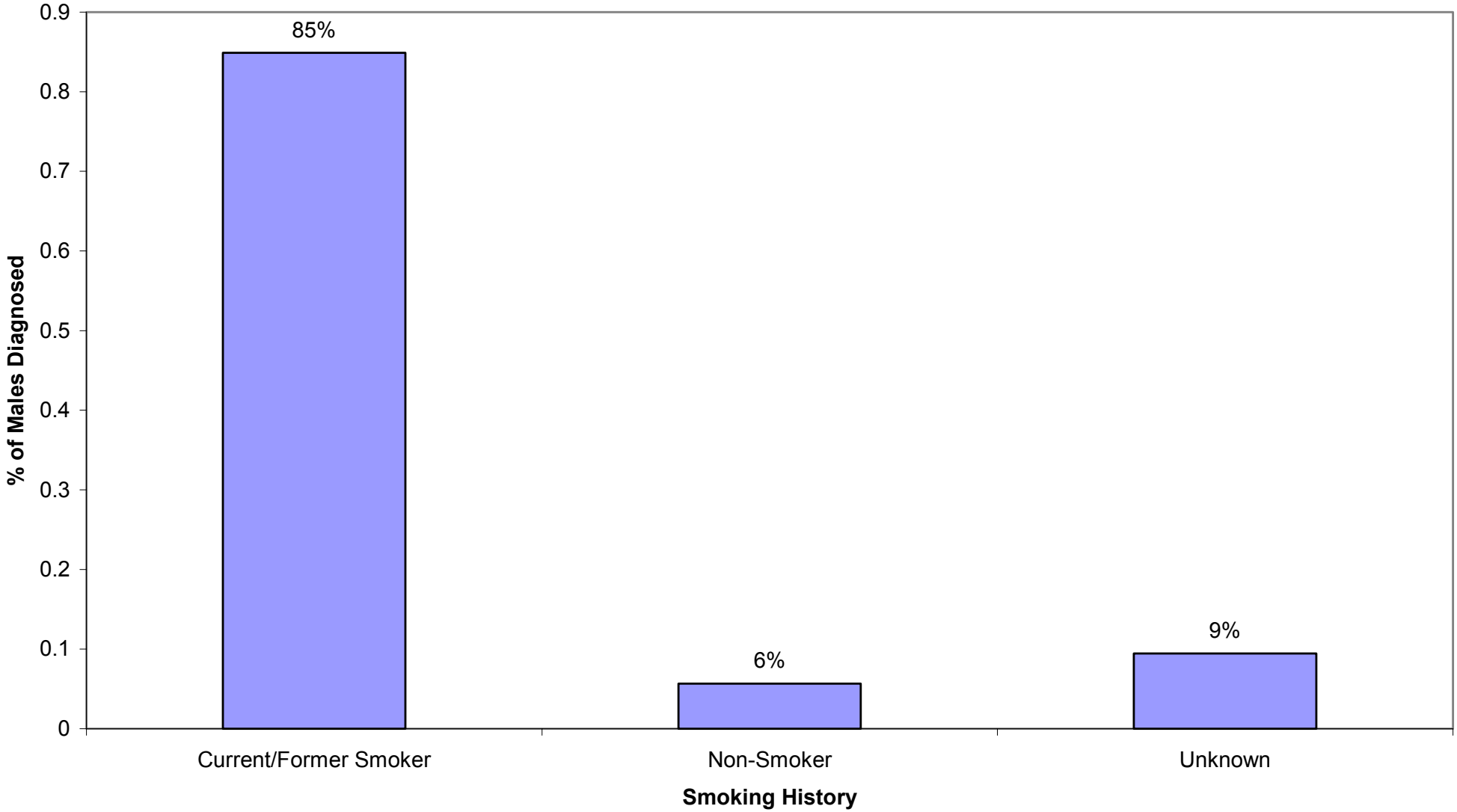


Figure 13
Smoking History Among Males Diagnosed with Lung Cancer in Marlborough CT 3213
1982-2002



TABLES

TABLE 1
Leukemia Incidence
Marlborough, MA
1982-2002

Census Tract	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
3211	12	8.6	140	72 --	244	5.0	4.8	104	34 --	243	7	4.3	163	65 --	335
3212	14	11.0	127	70 --	214	9.0	6.1	148	67 --	280	5	4.8	104	34 --	243
3213	18	11.9	151	90 --	239	11.0	6.6	167	83 --	298	7	5.4	130	52 --	267
3214	5	5.6	89	29 --	208	2.0	3.0	NC	NC --	NC	3	2.5	NC	NC --	NC
3215	23	11.7	197 *	125 --	295	10.0	6.2	161	77 --	297	13	5.5	236 *	126 --	404
3216	15	10.7	140	78 --	231	8.0	6.2	129	56 --	254	7	4.5	156	62 --	321
Total	87	59.6	146 *	117 --	180	45.0	33.0	136	99 --	182	42	27.1	155 *	112 --	209

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 2
Leukemia Incidence
Marlborough, MA
1982-1986

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	0	1.5	NC	NC -- NC	0	0.7	NC	NC -- NC	0	0.7	NC	NC -- NC
3212	2	2.2	NC	NC -- NC	0	1.2	NC	NC -- NC	2	1.0	NC	NC -- NC
3213	2	2.6	NC	NC -- NC	1	1.4	NC	NC -- NC	1	1.2	NC	NC -- NC
3214	1	1.1	NC	NC -- NC	0	0.6	NC	NC -- NC	1	0.5	NC	NC -- NC
3215	7	2.6	272 *	109 -- 561	5	1.3	372 *	120 -- 869	2	1.2	NC	NC -- NC
3216	4	2.1	NC	NC -- NC	2	1.2	NC	NC -- NC	2	0.9	NC	NC -- NC
Total	16	12.0	133	76 -- 216	8	6.4	125	54 -- 246	8	5.6	143	61 -- 281

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 3
Leukemia Incidence
Marlborough, MA
1987-1992

Census Tract	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
3211	4	1.9	NC	NC	NC	1	1.0	NC	NC	NC	3	0.9	NC	NC	NC
3212	2	2.7	NC	NC	NC	2	1.6	NC	NC	NC	0	1.1	NC	NC	NC
3213	8	2.9	272 *	117	536	6	1.6	366 *	134	796	2	1.3	NC	NC	NC
3214	2	1.3	NC	NC	NC	2	0.7	NC	NC	NC	0	0.6	NC	NC	NC
3215	6	2.9	206	75	448	2	1.6	NC	NC	NC	4	1.3	NC	NC	NC
3216	4	2.6	NC	NC	NC	3	1.5	NC	NC	NC	1	1.1	NC	NC	NC
Total	26	14.4	180 *	118	264	16	8.0	199 *	114	323	10	6.4	157	75	289

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 4
Leukemia Incidence
Marlborough, MA
1993-1998

Census Tract	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
3211	6	2.9	205	75 --	446	4	1.6	NC	NC --	NC	2	1.4	NC	NC --	NC
3212	6	3.3	184	67 --	401	5	1.8	272	88 --	634	1	1.4	NC	NC --	NC
3213	6	3.6	167	61 --	363	3	2.0	NC	NC --	NC	3	1.6	NC	NC --	NC
3214	2	1.7	NC	NC --	NC	0	0.9	NC	NC --	NC	2	0.8	NC	NC --	NC
3215	6	3.4	176	64 --	383	1	1.8	NC	NC --	NC	5	1.6	317 *	102 --	739
3216	4	3.3	NC	NC --	NC	2	1.9	NC	NC --	NC	2	1.4	NC	NC --	NC
Total	30	18.2	165 *	111 --	236	15	10.1	149	83 --	246	15	8.1	185 *	104 --	305

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 5
Leukemia Incidence
Marlborough, MA
1999-2002

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	2	2.9	NC	NC -- NC	0	1.5	NC	NC -- NC	2	1.4	NC	NC -- NC
3212	4	2.8	NC	NC -- NC	2	1.5	NC	NC -- NC	2	1.3	NC	NC -- NC
3213	2	3.0	NC	NC -- NC	1	1.6	NC	NC -- NC	1	1.4	NC	NC -- NC
3214	0	1.5	NC	NC -- NC	0	0.8	NC	NC -- NC	0	0.7	NC	NC -- NC
3215	4	2.8	NC	NC -- NC	2	1.5	NC	NC -- NC	2	1.4	NC	NC -- NC
3216	3	2.8	NC	NC -- NC	1	1.6	NC	NC -- NC	2	1.2	NC	NC -- NC
Total	15	15.9	94	53 -- 155	6	8.5	70	26 -- 153	9	7.4	122	55 -- 231

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 6
Liver Cancer Incidence
Marlborough, MA
1982-2002

Census Tract	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
3211	3	2.8	NC	NC	NC	2	1.9	NC	NC	NC	1	0.9	NC	NC	NC
3212	3	3.3	NC	NC	NC	2	2.4	NC	NC	NC	1	0.9	NC	NC	NC
3213	9	3.5	257 *	117	488	5	2.6	192	62	449	4	1.0	NC	NC	NC
3214	1	1.6	NC	NC	NC	1	1.2	NC	NC	NC	0	0.5	NC	NC	NC
3215	6	3.3	182	66	396	3	2.3	NC	NC	NC	3	1.0	NC	NC	NC
3216	6	3.2	188	68	408	5	2.5	200	64	467	1	0.7	NC	NC	NC
Total	28	18.0	156 *	103	225	18	13.0	138	82	219	10	4.9	204	98	375

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 7
Liver Cancer Incidence
Marlborough, MA
1982-1986

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC
3212	0	0.5	NC	NC -- NC	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC
3213	4	0.5	NC	NC -- NC	2	0.4	NC	NC -- NC	2	0.2	NC	NC -- NC
3214	1	0.2	NC	NC -- NC	1	0.1	NC	NC -- NC	0	0.1	NC	NC -- NC
3215	0	0.5	NC	NC -- NC	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC
3216	0	0.4	NC	NC -- NC	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC
Total	5	2.5	202	65 -- 473	3	1.6	NC	NC -- NC	2	0.8	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 8
Liver Cancer Incidence
Marlborough, MA
1987-1992

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	0	0.5	NC	NC -- NC	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC
3212	0	0.7	NC	NC -- NC	0	0.5	NC	NC -- NC	0	0.2	NC	NC -- NC
3213	3	0.8	NC	NC -- NC	2	0.5	NC	NC -- NC	1	0.2	NC	NC -- NC
3214	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC
3215	2	0.7	NC	NC -- NC	0	0.5	NC	NC -- NC	2	0.2	NC	NC -- NC
3216	1	0.7	NC	NC -- NC	1	0.5	NC	NC -- NC	0	0.2	NC	NC -- NC
Total	6	3.7	162	59 -- 352	3	2.6	NC	NC -- NC	3	1.1	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 9
Liver Cancer Incidence
Marlborough, MA
1993-1998

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	1	0.9	NC	NC -- NC	1	0.6	NC	NC -- NC	0	0.3	NC	NC -- NC
3212	2	1.0	NC	NC -- NC	1	0.8	NC	NC -- NC	1	0.3	NC	NC -- NC
3213	1	1.1	NC	NC -- NC	0	0.8	NC	NC -- NC	1	0.3	NC	NC -- NC
3214	0	0.5	NC	NC -- NC	0	0.4	NC	NC -- NC	0	0.1	NC	NC -- NC
3215	2	1.0	NC	NC -- NC	2	0.7	NC	NC -- NC	0	0.3	NC	NC -- NC
3216	4	1.0	NC	NC -- NC	3	0.8	NC	NC -- NC	1	0.2	NC	NC -- NC
Total	10	5.6	179	86 -- 329	7	4.1	170	68 -- 351	3	1.5	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 10
Liver Cancer Incidence
Marlborough, MA
1999-2002

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	2	1.1	NC	NC -- NC	1	0.8	NC	NC -- NC	1	0.3	NC	NC -- NC
3212	1	1.1	NC	NC -- NC	1	0.8	NC	NC -- NC	0	0.3	NC	NC -- NC
3213	1	1.1	NC	NC -- NC	1	0.9	NC	NC -- NC	0	0.3	NC	NC -- NC
3214	0	0.6	NC	NC -- NC	0	0.5	NC	NC -- NC	0	0.2	NC	NC -- NC
3215	2	1.1	NC	NC -- NC	1	0.8	NC	NC -- NC	1	0.3	NC	NC -- NC
3216	1	1.1	NC	NC -- NC	1	0.9	NC	NC -- NC	0	0.2	NC	NC -- NC
Total	7	6.2	112	45 -- 232	5	4.7	106	34 -- 247	2	1.5	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 11
Lung Cancer Incidence
Marlborough, MA
1982-2002

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	61	59.8	102	78 -- 131	37	31.8	116	82 -- 160	24	28.0	86	55 -- 128
3212	83	75.4	110	88 -- 136	46	43.4	106	78 -- 141	37	31.7	117	82 -- 161
3213	94	79.1	119	96 -- 145	65	45.0	144 *	111 -- 184	29	34.1	85	57 -- 122
3214	41	36.3	113	81 -- 153	23	21.5	107	68 -- 161	18	14.8	122	72 -- 192
3215	85	75.0	113	91 -- 140	52	42.7	122	91 -- 160	33	32.3	102	70 -- 143
3216	73	69.4	105	82 -- 132	40	40.7	98	70 -- 134	33	28.6	115	79 -- 162
Total	437	394.8	111 *	101 -- 122	263	225.2	117 *	103 -- 132	174	169.7	103	88 -- 119

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 12
Lung Cancer Incidence
Marlborough, MA
1982-1986

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	13	9.3	139	74 -- 238	7	5.4	130	52 -- 268	6	3.9	152	56 -- 331
3212	15	15.1	99	55 -- 164	9	9.7	92	42 -- 175	6	5.4	112	41 -- 243
3213	19	17.1	111	67 -- 174	16	10.8	148	85 -- 241	3	6.3	NC	NC -- NC
3214	8	6.6	121	52 -- 239	5	4.4	115	37 -- 268	3	2.2	NC	NC -- NC
3215	20	16.3	123	75 -- 189	12	10.3	117	60 -- 204	8	6.0	133	57 -- 261
3216	9	13.1	69	31 -- 131	8	8.4	95	41 -- 188	1	4.7	NC	NC -- NC
Total	84	77.6	108	86 -- 134	57	49.0	116	88 -- 151	27	28.6	94	62 -- 137

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 13
Lung Cancer Incidence
Marlborough, MA
1987-1992

Census Tract	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
3211	19	14.1	134	81	-- 210	11	7.6	144	72	-- 258	8	6.5	123	53	-- 243
3212	33	20.4	162 *	111	-- 227	20	12.3	162	99	-- 251	13	8.0	162	86	-- 276
3213	36	21.2	170 *	119	-- 235	23	12.5	184 *	117	-- 276	13	8.7	150	80	-- 256
3214	7	9.1	77	31	-- 158	3	5.6	NC	NC	-- NC	4	3.5	NC	NC	-- NC
3215	22	20.6	107	67	-- 162	13	12.0	108	57	-- 185	9	8.5	106	48	-- 201
3216	23	18.7	123	78	-- 184	12	11.4	105	54	-- 184	11	7.3	150	75	-- 268
Total	140	104.1	134 *	113	-- 159	82	61.6	133 *	106	-- 165	58	42.6	136	103	-- 176

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 14
Lung Cancer Incidence
Marlborough, MA
1993-1998

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	17	19.4	88	51 -- 141	9	10.2	88	40 -- 168	8	9.2	87	38 -- 172
3212	21	22.7	93	57 -- 142	11	12.6	87	43 -- 156	10	10.0	100	48 -- 183
3213	17	23.6	72	42 -- 115	14	12.9	108	59 -- 182	3	10.7	NC	NC -- NC
3214	12	11.3	106	55 -- 185	8	6.5	122	53 -- 241	4	4.8	NC	NC -- NC
3215	26	22.3	117	76 -- 171	16	12.2	132	75 -- 214	10	10.1	99	47 -- 182
3216	26	21.3	122	80 -- 179	10	12.2	82	39 -- 151	16	9.1	176	* 101 -- 286
Total	119	120.3	99	82 -- 118	68	66.5	102	79 -- 130	51	53.8	95	71 -- 125

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 15
Lung Cancer Incidence
Marlborough, MA
1999-2002

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	12	17.0	71	36 -- 123	10	8.6	117	56 -- 215	2	8.4	NC	NC -- NC
3212	14	17.2	82	45 -- 137	6	8.8	68	25 -- 148	8	8.3	96	41 -- 189
3213	22	17.2	128	80 -- 193	12	8.8	136	70 -- 237	10	8.4	119	57 -- 219
3214	14	9.3	150	82 -- 252	7	5.0	141	57 -- 291	7	4.3	161	65 -- 332
3215	17	15.8	107	62 -- 172	11	8.2	135	67 -- 241	6	7.7	78	29 -- 170
3216	15	16.3	92	52 -- 152	10	8.7	115	55 -- 211	5	7.5	66	21 -- 155
Total	94	92.8	101	82 -- 124	56	48.1	117	88 -- 151	38	44.7	85	60 -- 117

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 16
Childhood Leukemia Incidence
Marlborough, MA
1982-2002

Census Tract	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
3211	1	1.0	NC	NC -- NC	0	0.5	NC	NC -- NC	1	0.4	NC	NC -- NC
3212	1	1.1	NC	NC -- NC	1	0.6	NC	NC -- NC	0	0.5	NC	NC -- NC
3213	1	1.3	NC	NC -- NC	1	0.7	NC	NC -- NC	0	0.5	NC	NC -- NC
3214	2	0.6	NC	NC -- NC	1	0.4	NC	NC -- NC	1	0.3	NC	NC -- NC
3215	2	1.2	NC	NC -- NC	2	0.6	NC	NC -- NC	0	0.5	NC	NC -- NC
3216	4	1.4	NC	NC -- NC	4	0.8	NC	NC -- NC	0	0.7	NC	NC -- NC
Total	11	6.6	167	83 -- 298	9	3.7	243	* 111 -- 462	2	2.9	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected cases.
Expected number of cases presented are rounded to the nearest tenth.
SIRs and 95% CI are not calculated when observed number of cases < 5.

Obs = Observed number of cases
Exp = Expected number of cases
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Center for Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

Table 17 - Environmental Release and Spill Sites in Marlborough, MA [1]

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
1983-20021	C85-0007	RTE. 495 SOUTH OFF RTE. 20	TRUCK ACCIDENT	#2 FUEL OIL (UNK GAL)	1/9/1985		VEH. FUEL TANK
Mapped	C85-0083	MASS CONTAINER, CEDAR HILL RD	EARL DREW AND SONS	#6 FUEL OIL (UNK GAL)	5/6/1985		U.S.T.
Not Mapped	C85-0157	GAYE ST	OIL/ANTIFREEZE SPILL AT RESID.	OTHER MATERIAL, MOTOR OIL AND ANTIFREEZE (UNK GAL)	7/30/1985		OTHER SOURCE, AUTOMOBILE
Mapped	C85-0197	75 LAKE SHORE DR	OIL RELEASE AT RESIDENCE	#2 FUEL OIL (UNK GAL)	9/26/1985		ABOVE-GRND TANK
Not Mapped	C85-0268	RTE. 20, BORROWS SHOPPING PLZA	OIL ODORS IN CATCH BASIN	#2 FUEL OIL (UNK)	12/13/1985		
Not Mapped	C85-0269	INDIAN HILL SHOPPING CENTER	SIGNAL DELIVERY SERVICES	DIESEL FUEL (UNK GAL)	12/16/1985		VEH. FUEL TANK
Mapped	C86-0050	169 BROAD ST	LEACROIX PROPERTY	#2 FUEL OIL	2/28/1986		OTHER SOURCE, FEED LNE/BOILER
Mapped	C86-0058	THRESHER DR	MARLBORO MIDDLE SCHOOL	WASTE OIL (10-50 GAL)	3/11/1986		U.S.T.
Not Mapped	C86-0066	RTE 20/BUILDING #4	METRO CORP. CENTER/RAYTHEON	OTHER MATERIAL, FLOOR ADHESIVE	3/13/1986		OTHER SOURCE, DUMPSTER
Mapped	2-0000087	270 WEST MAIN ST	PROPERTY	UNKNOWN CHEMICAL OF UNKNOWN TYPE	4/24/1986	COMMERCIAL	
Mapped	C86-0159	270 W. MAIN ST	HUNT'S MOBIL	GASOLINE (10-50 GAL)	6/8/1986		U.S.T.
Not Mapped	C86-0160	GARMENTER RD	SLICK IN WATER ON MDC LAND		6/8/1986		
Mapped	C86-0231	PAMENTER RD	ABONDONED DRUM SUDBURY RESEVOIR	OTHER MATERIAL, PHOSPHORIC ACID (51-100 GAL)	8/1/1986		DRUM
Mapped	C86-0295	121 NORTHBORO RD	BRAENOOR NURSING HOME	#2 FUEL OIL (UNK GAL)	9/17/1986		U.S.T.
Mapped	C86-0287	175 MAPLE ST, DESIGN PACK	MARANE OIL	#4 FUEL OIL (101-250 GAL)	9/18/1986		U.S.T.
Mapped	C86-0300	UNION ST, MARL JR. HIGH SCHOOL	MARLBORO SCHOOL DEPT	#2 FUEL OIL (1001-5000 GAL)	9/24/1986		U.S.T.
Mapped	C86-0336	HILLSIDE SCHOOL, ROBIN HILL RD	CK SMITH	#2 FUEL OIL (UNK GAL)	10/20/1986		PIPE/HOSE/LINE
Mapped	C86-0366	290 TO 495 NORTH ON RAMP	TRANSPORT PLANNING & SERVICE	OTHER MATERIAL, HYCAR" LATEX" (LESS THAN 1 GAL)	11/10/1986		TANKER TRUCK
Mapped	C87-0010	7 CHURCH ST	ABOVE GND TANK RUPTURE	#2 FUEL OIL	1/13/1987		ABOVE-GRND TANK
Mapped	2-0000085	120 BARTLETT ST	BUTCHER POLISH CO	UNKNOWN CHEMICAL OF UNKNOWN TYPE	1/15/1987	INDUSTRIAL	UNKNOWN
Mapped	2-0000093	247 MAPLE ST	OLD COLONY GAS STATION	UNKNOWN CHEMICAL OF UNKNOWN TYPE	1/15/1987	GASSTATION	UST
Mapped	2-0000088	401 ELM ST	HONEYWELL	UNKNOWN CHEMICAL OF TYPE - OIL	1/15/1987	COMMERCIAL, MANUFACT	DRUMS, DRYWELL
Mapped	C87-0181	215 MAPLE ST	ABANDONED GASOLINE TANK	GASOLINE (UN)	1/22/1987		U.S.T.
Not Mapped	C87-0044	63 MILL ST	TANKER TRUCK LEAK	DIESEL FUEL (101-250 GAL)	2/5/1987		TANKER TRUCK

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	C87-0081	ROBIN HILL RD	PATTEN HOUSE/HILLSIDE SCHOOL	#2 FUEL OIL (51-100 GAL)	3/7/1987		ABOVE-GRND TANK
Mapped	C87-0238	420 MAPLE ST	CAR IN POND	OTHER MATERIAL, GASOLINE & CRANKCASE OIL (UNK)	6/5/1987		VEH. FUEL TANK
Mapped	C87-0260	RTE. 290 @ 495	TRUCK ACCIDENT	DIESEL FUEL (101-250 GAL)	6/19/1987		VEH. FUEL TANK
Mapped	C87-0326	100 NICKERSON RD		ETHYLENE GLYCOL	6/20/1987		
Mapped	2-0000092	260 WEST MAIN ST	MOBIL GAS STATION 01 POA	UNKNOWN CHEMICAL OF UNKNOWN TYPE	7/15/1987	COMMERCIAL	PIPE
Mapped	C87-0112	235 BOSTON POST RD	MARLBORO	LUBRICATING OIL (501-1000 GAL)	7/29/1987		PIPE/HOSE/LINE
Mapped	C87-0312	235 BOSTON POST RD	OIL PIPE RUPTURE	LUBRICATING OIL (UNK)	7/29/1987		PIPE/HOSE/LINE
Mapped	C87-0338	167 LAKESIDE		SODIUM HYDROXIDE	8/19/1987		DRUM
Mapped	C87-0355	MAPLE ST AND JOHN ST	RTE #85 MARLBORO	GASOLINE (1-10 GAL)	8/28/1987		VEH. FUEL TANK
Mapped	C87-0427	554 BOSTON POST RD	CUMBERLAND FARMS	PERCHLOROETHYLENE (UNK)	10/22/1987		PIPE/HOSE/LINE
Mapped	C87-0467	40 CRANE MEADOW RD		WASTE OIL	11/19/1987		ABOVE-GRND TANK
Mapped	C87-0490	40 CRANE MEADOW RD	STOP & SHOP	WASTE OIL	11/19/1987		ABOVE-GRND TANK
Mapped	C87-0489	1001 BOSTON POST RD	RAYTHEON	#2 FUEL OIL (251-500 GAL)	12/10/1987		U.S.T.
Not Mapped	C87-0499	BOSTON POST RD	TANKER TRUCK SPILL	DIESEL FUEL (101-250 GAL)	12/15/1987		VEH. FUEL TANK
Not Mapped	C88-0006	BEACH ST		GASOLINE (1-10 GAL)	1/11/1988		OTHER SOURCE, PORTABLE TANK
Mapped	C88-0008	85 HAYES MEMORIAL DR		MINERAL SPIRITS (1-10 GAL)	1/12/1988		OTHER SOURCE, TRUCK
Not Mapped	C88-0027	1034 E. MAIN ST		#2 FUEL OIL (1-10 GAL)	1/17/1988		ABOVE-GRND TANK
Not Mapped	C88-0695	83 MILL ST		MISCELLANEOUS OIL (101-250 GAL)	2/5/1988		
Not Mapped	C88-0122	HARUND ST		WASTE OIL	3/15/1988		ABOVE-GRND TANK
Not Mapped	C88-0107	HARVARD ST	TONIFER CORP.	WASTE OIL (10-50 GAL)	3/15/1988		PIPE/HOSE/LINE
Not Mapped	C88-0180	BRIGHAM ST	N.E. TELEPHONE LEARNING SCHOOL	GASOLINE	4/12/1988		OTHER SOURCE, RESIDUAL GAS
Not Mapped	C88-0187	RT. 20 WEST		DIESEL FUEL (10-50 GAL)	4/19/1988		VEH. FUEL TANK
Not Mapped	C88-0183	MAIN ST	FIRE DEPT	DIESEL FUEL (10-50 GAL)	4/21/1988		VEH. FUEL TANK
Mapped	C88-0270	413 LAKESIDE AVE	SHELL STATION	GASOLINE	6/20/1988		U.S.T.
Not Mapped	C88-0689	BARTLET ST	SHIPLEY CHEMICAL	UNKNOWN	7/15/1988		OTHER SOURCE, BOTTLES OF UNK
Mapped	C88-0394	LAKE WILLIAMS RESERVOIR		UNKNOWN	8/4/1988		
Mapped	C88-0417	152 DARTMOUTH ST		GASOLINE (10-50 GAL)	8/15/1988		VEH. FUEL TANK
Mapped	C88-0423	MILL ST AND SOUTH ST		HYDRAULIC FLUID (10-50 GAL)	8/18/1988		PIPE/HOSE/LINE

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	C88-0520	UNION ST	MIDDLE SCHOOL	#6 FUEL OIL	9/26/1988		U.S.T.
Mapped	C88-0523	386 MAPLE ST		GASOLINE (10-50 GAL)	10/2/1988		VEH. FUEL TANK
Mapped	2-0000292	114 EAST MAIN ST	MARLBORO EXXON	PETROLEUM BASED OIL	10/15/1988	GASSTATION	UNKNOWN
Mapped	2-0000446	146 MAPLE ST	GULF STATION	UNKNOWN CHEMICAL OF UNKNOWN TYPE	10/15/1988	GASSTATION	UST
Mapped	2-0000317	230 MAPLE ST	BEACON COMMUNICATIONS CORP	UNKNOWN CHEMICAL OF UNKNOWN TYPE	10/15/1988		
Mapped	2-0000403	247A MAPLE ST	KENNEDYS PUB	UNKNOWN CHEMICAL OF UNKNOWN TYPE	10/15/1988		
Not Mapped	C88-0674	RTE 20	LAKESIDE AVE	NON-PETROLEUM OIL	10/21/1988		DRUM
Not Mapped	C88-0528	RTE 20 WEST		GASOLINE	11/6/1988		U.S.T.
Mapped	2-0000086	134 WEST MAIN ST	ACME GLASS	UNKNOWN CHEMICAL OF UNKNOWN TYPE	1/15/1989		
Mapped	2-0000332	311 MAPLE ST	SUPERIOR AUTOBODY	UNKNOWN CHEMICAL OF UNKNOWN TYPE	1/15/1989		
Mapped	2-0000464	656 BOSTON POST RD	STARRETT PAVING CO	UNKNOWN CHEMICAL OF UNKNOWN TYPE	1/15/1989		
Mapped	C89-0048	123 FELTON ST	COEHLER MANUFACTURING CO.	OTHER MATERIAL, LEAD CARBONATE (UNK)	1/17/1989		OTHER SOURCE, TANK
Not Mapped	C89-0099	SOUTH ST PAST EMIT OFF WST		#2 FUEL OIL (101-250 GAL)	2/24/1989		PIPE/HOSE/LINE
Mapped	C89-0116	255 EAST MAIN ST		SOLVENT	3/6/1989		DRUM
Mapped	2-0000482	187 MILLHAM RD	187 MILLHAM RD PROPERTY	UNKNOWN CHEMICAL OF UNKNOWN TYPE	4/15/1989		
Mapped	2-0000559	413 LAKESIDE AVE	SHELL OIL COMPANY	UNKNOWN CHEMICAL OF UNKNOWN TYPE	4/15/1989	GASSTATION	UST
Mapped	2-0000225	843 BOSTON POST RD	GIROUX BROS TRANSPORTATION	UNKNOWN CHEMICAL OF UNKNOWN TYPE	4/15/1989		
Not Mapped	2-0000585	AMES GLEN ST	METAL GOODS PARCEL	UNKNOWN CHEMICAL OF UNKNOWN TYPE	4/15/1989		
Mapped	C89-0214	112 FOREST ST		MINERAL SPIRITS	4/26/1989		OTHER SOURCE, FROM CONTAINER
Mapped	C89-0238	342 BOSTON POST RD		GASOLINE (UNK)	5/3/1989		U.S.T.
Not Mapped	C89-0284	SHERMAN ST	RESERVOIR	GASOLINE (UNK)	5/11/1989		VEH. FUEL TANK
Mapped	C89-0291	100 PHELP RD		OTHER MATERIAL, FERTILIZER	5/18/1989		PIPE/HOSE/LINE
Mapped	C89-0293	40 CEDAR HILL RD		SODIUM HYDROXIDE	5/22/1989		OTHER SOURCE, UNKNOWN
Mapped	2-0000516	103 EAST MAIN ST	PROPERTY	PETROLEUM BASED OIL	6/5/1989	RESIDNTIAL	AST
Not Mapped	C89-0330	RT 20		UNKNOWN (UNK)	6/8/1989		OTHER SOURCE, DUMPSTER
Mapped	C89-0361	543 BROAD & LINCOLN ST		GASOLINE (UNK)	6/20/1989		U.S.T.
Not Mapped	C89-0366	MAIN ST		GASOLINE (UNK)	6/21/1989		PIPE/HOSE/LINE

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	C89-0386	265 EUELINA DR		OTHER MATERIAL, PESTICIDES (1-10 GAL)	6/29/1989		TANKER TRUCK
Mapped	2-0000655	123 FELTON ST	KOEHLER MANUFACTURING	UNKNOWN CHEMICAL OF UNKNOWN TYPE	7/15/1989	MANUFACT	
Mapped	2-0000634	215 MAPLE ST	SPACE AGE ELECTRONICS	CYANIDE, PETROLEUM BASED OIL, UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL, UNKNOWN CHEMICAL OF TYPE - OIL, UNKNOWN CHEMICAL OF UNKNOWN TYPE	7/15/1989	COGASPLANT, FORMER, INDUSTRIAL	LAGOON, UNKNOWN
Not Mapped	C89-0475	AMES ST	TRUCKLEASE CO. TRUCK LEAK	DIESEL FUEL (10-50)	8/11/1989		VEH. FUEL TANK
Mapped	C89-0474	PARMENTER RD	MDC RESERVIOR	GASOLINE	8/11/1989		VEH. FUEL TANK
Mapped	C89-0512	BOSTON POST RD	GOTHAM, INC.	OTHER MATERIAL, TITANIUM DIOXIDE (1-10 UNK)	8/30/1989		OTHER SOURCE, 5 GAL CONTAINER
Mapped	C89-0534	202 LAKESHORE AVE	DUMPSTER LIQUID RELEASE	ACID (MISCELLANEOUS) (1-10 UNK)	9/13/1989		OTHER SOURCE, DUMPSTER
Not Mapped	C89-0567	DOUCETTE DR	SOIL DISPOSAL-KANE	OTHER MATERIAL, PETROLEUM CONTAMINATED (10-50 UNK)	9/20/1989		OTHER SOURCE, DUMP TRUCK
Mapped	C89-0602	50A BRIGHAM ST	SAFETY KLEEN CORP.	PERCHLOROETHYLENE (10-50 GAL)	10/11/1989		DRUM
Not Mapped	C89-0603	LOWER MILLHAM RD	MARLBORO FISH & GAME PROPERTY	OTHER MATERIAL, VEGETABLE OIL (UNK)	10/12/1989		OTHER SOURCE, UNKNOWN
Not Mapped	2-0000661	639 883 BOSTON POST RD	INDIAN HILL PARK	BTEX	10/15/1989	OPENSPACE, WETLANDS	DRUMS, LAGOON, PIPE
Not Mapped	C89-0612	MAIN ST, RTE 20	MARLBOROUGH FIRE STATION	OTHER MATERIAL, GASOLINE CONTAM. DEBRIS (< 1 DRUM)	10/19/1989		DRUM
Mapped	C89-0621	54 MECHANIC ST	TANK OVERFILL	#2 FUEL OIL (51-100 GAL)	10/25/1989		PIPE/HOSE/LINE
Mapped	2-0000647	86 PLEASANT ST	OLD WEST MEETING HOUSE	UNKNOWN CHEMICAL OF UNKNOWN TYPE	10/31/1989	COMMERCIAL	UST
Mapped	C89-0659	MEAL & VALLY ST	MARLBOROUGH DPW	GASOLINE	11/13/1989		U.S.T.
Mapped	C89-0679	VALLEY ST	MARLBOROUGH DPW	HYDRAULIC FLUID	11/20/1989		OTHER SOURCE, FRONTEND LOADER
Mapped	2-0000687	445 LAKESIDE AVE	MARANE OIL	PETROLEUM BASED OIL	11/22/1989	GASSTATION	UST
Mapped	C89-0759	300 CEDAR HILL RD	MASS. CONTAINER CORP.	#2 FUEL OIL (UNK)	12/18/1989		U.S.T.
Mapped	C89-0746	300 CEDAR HILL ST	MASSACHUSETTS CONTAINER CORP.	DIESEL FUEL (UNK)	12/18/1989		U.S.T.
Not Mapped	C90-0077	RTE 85		GASOLINE (10-50 CUBIC YDS)	2/15/1990		OTHER SOURCE, MYSTERY
Mapped	C90-0195	50A BRIGHAM ST	SAFTY KLEEN	OTHER MATERIAL, PETROLEUM NAPTHA	4/5/1990		PIPE/HOSE/LINE
Mapped	C90-0256	RTE. 20 & FELTERS ST	SHELL OIL SPILL	GASOLINE (LESS THAN 1 GAL)	4/26/1990		VEH. FUEL TANK
Mapped	C90-0281	529 BOSTON POST RD	MOBIL OIL CO.	GASOLINE	5/9/1990		OTHER SOURCE, ST.II VAP. REC.

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Not Mapped	C90-0310		SAFETY KLEEN	SOLVENTS	5/17/1990		DRUM
Mapped	C90-0329	FARM RD	AIRPORT CRASH	AVIATION GAS (1-10 GAL)	5/27/1990		VEH. FUEL TANK
Mapped	C90-0347	91 MAIN ST	HYDRAULIC FLUID	HYDRAULIC FLUID	6/5/1990		PIPE/HOSE/LINE
Not Mapped	C90-0364	I-495 & MASS PIKE (EX. 11A)	BUILDERS TRANSPORT	DIESEL FUEL (10-50 GAL)	6/11/1990		VEH. FUEL TANK
Mapped	2-0000763	279 MAPLE ST	MARLCO FACILITY 98 MRL FORMER	GASOLINE	6/26/1990	COMMERCIAL, GASSTATION	UST
Mapped	2-0000774	329-331 LINCOLN ST	FOSSILE CONSTRUCTION	PETROLEUM BASED OIL	7/3/1990	FORMER, GASSTATION	UST
Mapped	C90-0418	364 MAPLE ST	GARAGE-WASTE OIL RELEASE	OTHER MATERIAL, GASOLINE & WASTE OIL (UNK)	7/9/1990		ABOVE-GRND TANK
Mapped	C90-0568	167 NORTHBORO RD	BOROUGH'S TIRE CO.	WASTE OIL (UNK)	7/13/1990		OTHER SOURCE, CATCH BASIN
Mapped	2-0000751	111 HAYES MEMORIAL DR	NEC TECHNOLOGIES INC	UNKNOWN CHEMICAL OF UNKNOWN TYPE	8/8/1990		
Mapped	C90-0590	RTE. 290 EAST RAMP/TO RTE. 495	CARTER'S TRUCKING	DIESEL FUEL (10-50 GAL)	9/19/1990		VEH. FUEL TANK
Mapped	C90-0701	237 CEDAR HILL RD	ANCAN TRUCKING	DIESEL FUEL	11/5/1990		VEH. FUEL TANK
Mapped	C90-0721	67 CHESTNUT ST	WASTE OIL DRUM SPILL	WASTE OIL (10-50 GAL)	11/9/1990		DRUM
Mapped	C90-0787	RTE 495 SOUTH/RTE 290	TANKER ROLLOVER - W.M. HOLDMAN	DIESEL FUEL (51-100 GAL)	12/11/1990		VEH. FUEL TANK
Mapped	C91-0019	FELTON ST	KOHLER MAUFACTURING	OTHER MATERIAL, MINERAL SPIRITS	1/12/1991		ABOVE-GRND TANK
Not Mapped	C91-0032	FELTER ST	WASTE WATER TREATMENT PLANT	OTHER MATERIAL, MINERAL SPIRITS	1/17/1991		OTHER SOURCE, UNKNOWN
Mapped	C91-0040	114 E. MAIN ST	NO SITUATION AT THIS TIME	GASOLINE (UNK GAL)	1/24/1991		
Mapped	C91-0041	2 RESULTS WAY	DIGITAL EQUIPMENT CORP.	#2 FUEL OIL	1/24/1991		U.S.T.
Mapped	C91-0089	33 HAYES MEMORIAL DR	ROTATION DYNAMICS	#4 FUEL OIL	2/26/1991		TANKER TRUCK
Mapped	C91-0138	410 LAKESIDE AVE	EXXON IN EVERETTE	GASOLINE (UNK GAL)	3/25/1991		U.S.T.
Mapped	C91-0167	58 BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, MINERAL SPIRITS	4/9/1991		DRUM
Mapped	2-0000727	399 BERLIN RD	HOUDE FARM FMR	UNKNOWN CHEMICAL OF UNKNOWN TYPE	4/15/1991	FARM	UST
Mapped	C91-0190	50A BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, PETRO NAPTHA	4/23/1991		
Mapped	C91-0215	550 FARM RD	DRUMS OF PAINT WASTE	OTHER MATERIAL, PAINT RELATED WASTE (UNK GAL)	5/2/1991		DRUM
Mapped	C91-0242	111 LOCK DR	DEC	#2 FUEL OIL (UNK CUBIC YDS)	5/7/1991		U.S.T.
Not Mapped	C91-0252	BEHIND BROOK ST	WASTE OIL DUMPED BEHIND DPW	WASTE OIL (UNK GAL)	5/16/1991		
Mapped	C91-0441	495, 290	LEASWAY TRANSFER POOL	DIESEL FUEL (UNK GAL)	7/10/1991		VEH. FUEL TANK

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	C91-0383	496 LINCOLA ST	S.E. ESSEX OPPORTUNITY COUNCIL	WASTE OIL	7/30/1991		VEH. FUEL TANK
Not Mapped	C91-0414	MAIN ST	PAOLINI CONSTRUCTION CO.	HYDRAULIC FLUID (1-10 GAL)	8/1/1991		PIPE/HOSE/LINE
Not Mapped	C91-0423	RTE. 20 SHELL STATION	HOLE IN M.V. GAS TANK	GASOLINE (1-10 GAL)	8/15/1991		VEH. FUEL TANK
Mapped	C91-0450	150 MAPLE ST	SAFETY KLEEN	OTHER MATERIAL, MINERAL SPIRITS (UNK GAL)	8/29/1991		DRUM
Mapped	C91-0475	43 MECHANIC ST	DUMPING OF OIL	OTHER MATERIAL, OIL + ANTIFREEZE (UNK GAL)	9/10/1991		VEH. FUEL TANK
Mapped	2-0000856	771 BOSTON POST RD	SALVAGE YARD FMR	UNKNOWN CHEMICAL OF TYPE - OIL	9/18/1991	JUNKYARD	
Mapped	C91-0512	FELTON ST	KOELHER MFG.	OTHER MATERIAL, PETROLEUM NAPTHALINE (UNK)	9/24/1991		
Not Mapped	C91-0550	JOHANSON DR	MASS ELECTRIC	TRANSFORMER OIL (UNK GAL)	10/18/1991		TRANSFORMER
Mapped	C91-0558	20 HIGH ST	CHANGED OIL AND DUMPED W. OIL	LUBRICATING OIL (UNK GAL)	10/23/1991		VEH. FUEL TANK
Mapped	C91-0581	58 BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, ANTIFREEZE (UNK GAL)	11/1/1991		PIPE/HOSE/LINE
Mapped	C91-0615	50A BRIGHAM ST	SAFETY KLEEN CORP.	WASTE OIL (UNK GAL)	11/27/1991		TANKER TRUCK
Not Mapped	C91-0661	PARMETER RD	OVERTURNED CAMPER	GASOLINE (UNK GAL)	12/28/1991		VEH. FUEL TANK
Mapped	C92-0006	469 BOSTON POST RD	MOTOR OIL IN PARKING LOT	MOTOR OIL (UNK GAL)	1/5/1992		VEH. FUEL TANK
Not Mapped	C92-0016	RTE 20, PAST TIME RESTAURANT	RUPTURED VEHICLE FUEL TANK	GASOLINE (11-50 GAL)	1/12/1992		VEH. FUEL TANK
Mapped	2-0000832	167 NORTHBORO RD	BOROUGHS TIRE CO	PETROLEUM BASED OIL	1/15/1992	GASSTATION	UST
Mapped	C92-0021	50A BRIGHAM ST	SAFETY KLEEN CORP.	OTHER MATERIAL, WASTE PETROLEUM NAPHTHA (1-10 GAL)	1/16/1992		PIPE/HOSE/LINE
Mapped	C92-0150	299 MAPLE ST	FLYNN'S TEXACO	GASOLINE (11-50 GAL)	4/10/1992		TANKER TRUCK
Mapped	C92-0152	FOREST ST AT CEDAR HILL	DRUMS	OTHER MATERIAL, POSSIBLE HYDRAULIC FLUID (UNK)	4/10/1992		DRUM
Mapped	C92-0205	455 FOREST ST	SHIPLEY CO.	OTHER MATERIAL, POTASSIUM PEROXYMONOSULFT (UNK)	5/5/1992		DRUM
Mapped	C92-0216	50A BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, PET NAPTHA, MINERAL SPRTS (UNK GAL)	5/8/1992		DRUM
Mapped	C92-0214	I 495 SOUTH AND I 290 WEST	DAY AND ROSS TRUCKING CO.	DIESEL FUEL (101-250 GAL)	5/8/1992		VEH. FUEL TANK
Mapped	C92-0277	431 LINCOLN ST	SHELL SERVICE STATION	GASOLINE (UNK CUBIC YDS)	6/4/1992		OTHER SOURCE, UNKNOWN
Mapped	C92-0294	BARTLETT & HAYES MEMORIAL DR	MASS ELECTRIC	TRANSFORMER OIL (51-100 GAL)	6/11/1992		TRANSFORMER
Mapped	C92-0287	50A BRIGHAM ST	MINERAL SPIRITS	MINERAL SPIRITS (1-10 GAL)	6/12/1992		TANKER TRUCK
Mapped	C92-0312	RTE. 290 & RTE. 495	VALLERIE TRANSPORTATION	DIESEL FUEL (11-50 GAL)	6/23/1992		VEH. FUEL TANK

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	C92-0342	14 JOHN ST	NEW ENGLAND TELEPHONE	GASOLINE (UNK)	7/10/1992		U.S.T.
Mapped	2-0000908	300 CEDAR HILL ST	MASSACHUSETTS CONTAINER CORP	UNKNOWN CHEMICAL OF UNKNOWN TYPE	8/26/1992	TANK FARM	
Mapped	C92-0431	529 BOSTON POST RD	MOBIL SERVICE STATION	GASOLINE (UNK)	8/27/1992		PIPE/HOSE/LINE
Mapped	C92-0444	RTE. 495 S AT RTE. 20	MATUSZKO TRUCKING	DIESEL FUEL (UNK GAL)	9/3/1992		VEH. FUEL TANK
Mapped	2-0000923	301 MAPLE ST	DIAMOND BULK OIL PLANT	OIL, UNKNOWN CHEMICAL OF TYPE - OIL	10/15/1992	COMMERCIAL, FORMER, TANK FARM	AST, UST
Mapped	C92-0521	14 MT. PLEASANT ST	RELEASE OF OIL AT RESIDENCE	#2 FUEL OIL (UNK)	10/16/1992		U.S.T.
Not Mapped	C92-0527	BRIGHAM ST	NEW ENGLAND TELEPHONE	#2 FUEL OIL (UNK)	10/17/1992		U.S.T.
Mapped	C92-0536	117 KINGS GRANT RD	OIL SPILL AT RESIDENCE	#2 FUEL OIL (1-10 GAL)	10/23/1992		ABOVE-GRND TANK
Mapped	2-0000961	299 MAPLE ST	TEXACO SERVICE STATION	PETROLEUM BASED OIL	1/4/1993	COMMERCIAL, GASSTATION	UNKNOWN
Mapped	C93-0008	50A BRIGHAM ST	SAFETY KLEEN	SOLVENTS (UNK GAL)	1/7/1993		OTHER SOURCE, PUMP GASKET
Mapped	C93-0058	455 FOREST ST	SHIPLEY CO.	OTHER MATERIAL, FLUORINE GAS (UNK GAL)	2/8/1993		OTHER SOURCE, CYLINDER
Mapped	C93-0083	50A BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, WASTE MINERAL SPIRITS (UNK GAL)	2/22/1993		DRUM
Mapped	C93-0090	50A BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, MINERAL SPIRITS (1-10 GAL)	3/1/1993		TANKER TRUCK
Mapped	C93-0119	5A BRIGHAM ST	SAFETY CLEAN	OTHER MATERIAL, NAPTHA (1-10 GAL)	3/18/1993		DRUM
Mapped	C93-0248	50A BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, PETROLEUM NAPTHA (1-10 GAL)	5/18/1993		DRUM
Not Mapped	C93-0269	STREAM	CAR IN STREAM	GASOLINE (UNK GAL)	5/31/1993		VEH. FUEL TANK
Mapped	2-0001057	431 LINCOLN ST	SHELL STATION	PETROLEUM BASED OIL	7/13/1993	GASSTATION	UST
Mapped	2-0000979	40 HAYES MEMORIAL DR	HB FULLER COMPANY	UNKNOWN CHEMICAL OF TYPE - OIL	7/15/1993	INDUSTRIAL, MANUFACT	
Mapped	C93-0365	FARM RD	KANE ELEMENTARY SCHOOL	DIESEL FUEL (UNK GAL)	7/29/1993		BELOW-GRND TANK
Mapped	C93-0385	50A BRIGHAM ST	SAFETY KLEEN	OTHER MATERIAL, PETROLEUM NAPTHA (1-10 GAL)	8/6/1993		DRUM
Mapped	C93-0446	99 WEST MAIN ST	LEAKING FILL LINE	#2 FUEL OIL (UNK GAL)	8/30/1993		ABOVE-GRND TANK
Mapped	C93-0462	53 RED SPRING RD		#2 FUEL OIL (1-10 GAL)	9/16/1993		ABOVE-GRND TANK
Not Mapped	2-0001091	SOUTH ST	MASS ELECTRIC	UNKNOWN CHEMICAL OF UNKNOWN TYPE	9/27/1993	SUBSTATION	TRANSFORM
Not Mapped	2-0001086	BARTLETT ST	MASS ELECTRIC	UNKNOWN CHEMICAL OF UNKNOWN TYPE	9/28/1993	SUBSTATION	TRANSFORM

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	2-0010032	150 CEDAR HILL ST	KENS FOODS	DIESEL FUEL, PETROLEUM BASED OIL, WASTE OIL	10/1/1993	COMMERCIAL	UST
Mapped	2-0001087	223 MAPLE ST	SUNOCO STATION	UNKNOWN CHEMICAL OF UNKNOWN TYPE	10/1/1993	GASSTATION	UST
Not Mapped	2-0001078	DONALD LYNCH BLVD	EL DAUPHINAIS	UNKNOWN CHEMICAL OF TYPE - OIL	10/1/1993	INDUSTRIAL	UST
Mapped	2-0010143	299 MAPLE ST	TEXACO SERVICE STATION	GASOLINE	10/14/1993	COMMERCIAL	UNKNOWN
Mapped	2-0010083	215 MAPLE ST	PROPOSED FIRE STATION	COAL TAR PITCH (150 GAL), WASTE OIL (36 GAL)	11/15/1993	MUNICIPAL	PIPE
Mapped	2-0010101	82 FLORENCE ST	POLE 8	MINERAL OIL (12 GAL), MINERAL OIL (40 GAL)	11/28/1993	ROADWAY	TRANSFORM
Mapped	2-0010125	197 NORTHBORO RD	INT RTE 20 NEXT TO MCDONALDS	GASOLINE	12/15/1993	COMMERCIAL, ROADWAY	UNKNOWN
Mapped	2-0010167	53 RED SPRING RD	RESIDENTIAL	PETROLEUM BASED OIL, PETROLEUM BASED OIL	1/24/1994	RESIDNTIAL	AST
Mapped	2-0010177	129 WOODLAND DR	DRIVEWAY	FUEL OIL #2 (10 GAL), FUEL OIL #2 (10 GAL)	1/28/1994	RESIDNTIAL	TANKER
Mapped	2-0010185	50A BRIGHAM ST	SAFETY KLEEN FACILITY	AROMATIC SOLVENT (33.5 LBS), AROMATIC SOLVENT (5 GAL)	2/7/1994	COMMERCIAL	DRUMS
Mapped	2-0010249	197 NORTHBORO RD	RK PLAZA NEXT TO MCDONALDS	2-BUTANONE, 2-BUTANONE (2500 GAL)	3/15/1994	COMMERCIAL	UTILITY, VAULT
Mapped	2-0010300	455 FOREST ST	SHIPLEY CO	2-PROPANOL, 1-METHOXY- (800 LBS), 2-PROPANOL, 1-METHOXY- (800 LBS)	5/6/1994	COMMERCIAL	DRUMS
Mapped	2-0010336	25 BROAD ST	ST MARYS CHURCH	FUEL OIL #2 (10 GAL), FUEL OIL #2 (50 PPMV)	6/16/1994	CHURCH	UST
Mapped	2-0010525	40 CRANE MEADOW RD	COR CEDAR HILL RD	AMMONIA, AMMONIA (50 LBS)	10/26/1994	COMMERCIAL, INDUSTRIAL	PIPE
Mapped	2-0010629	342 BOSTON POST RD	SHELL SERVICE STA	BENZENE, DIMETHYL (7800 PPB), BENZENE, METHYL- (12000 PPB)	1/10/1995	COMMERCIAL	FUEL TANK
Mapped	2-0010699	146 MAPLE ST	BAKERLY CITGO-KING BRAKES	DIESEL FUEL, GASOLINE	3/11/1995	COMMERCIAL, INDUSTRIAL, ROADWA	PIPE, UST
Mapped	2-0010724	289 ELM ST	MACNEILL ENG	LUBRICATING OIL (25 GAL)	4/11/1995	INDUSTRIAL	AST
Mapped	2-0010742	21 PROSPECT ST	IMMACULATE CONCEPTION CHURCH	FUEL OIL #2 (100 PPMV), PETROLEUM BASED OIL (50 PPMV)	4/21/1995		UST
Mapped	2-0010787	202 RESERVOIR RD	UTIL POLE 16	MINERAL OIL (25 GAL)	5/21/1995	RIGHTOFWAY, ROADWAY	TRANSFORM
Mapped	2-0010795	100 CEDAR HILL ST	SUBURBAN PROPANE	DIESEL FUEL (220 PPMV)	5/24/1995	COMMERCIAL	UST
Mapped	2-0010881	300 CEDAR HILL ST	MA CONTAINER CORP	DIESEL FUEL (3800 PPM)	8/9/1995	INDUSTRIAL	UNKNOWN
Mapped	2-0010892	50A BRIGHAM ST	SAFETY KLEEN	UNKNOWN CHEMICAL OF TYPE - OIL (3 GAL)	8/24/1995	COMMERCIAL	DRUMS

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	2-0010911	50A BRIGHAM ST	SAFETY KLEEN FACILITY	UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (10 GAL)	9/13/1995	COMMERCIAL	DRUMS
Mapped	2-0010914	50A BRIGHAM ST	SAFETY KLEEN CORP	UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (10 GAL)	9/14/1995	COMMERCIAL	DRUMS
Mapped	2-0011001	342 BOSTON POST RD	SHELL SERVICE STA	TOTAL PETROLEUM HYDROCARBONS (TPH) (930 MG/KG)	11/14/1995	COMMERCIAL	MIX TRAP
Mapped	2-0011038	50A BRIGHAM ST	SAFETY KLEEN FACILITY	UNKNOWN CHEMICAL OF TYPE - OIL (7 GAL)	12/14/1995	COMMERCIAL	DRUMS
Mapped	2-0011048	300 CEDAR HILL ST	MASS CONTAINER CORP	FUEL OIL #4 (50 GAL)	12/26/1995	COMMERCIAL	UST
Mapped	2-0011132	FLORENCE ST	FLORENCE ST SUBSTA	UNKNOWN CHEMICAL OF TYPE - OIL (57 PPM)	2/5/1996	COMMERCIAL, ROADWAY	TRANSFORM
Mapped	2-0011108	123 FELTON ST	KOEHLER MANUFACTURING	SULFURIC ACID (1200 GAL)	2/15/1996	INDUSTRIAL	TANKER
Mapped	2-0011118	CEDAR HILL ST	DANGELO DRIVE	DIESEL FUEL (80 GAL)	2/21/1996	COMMERCIAL, ROADWAY	TANKER
Mapped	2-0011164	740 BOSTON POST RD	NISSAN DEALERSHIP	GASOLINE (250 PPMV)	3/19/1996	COMMERCIAL	UST
Not Mapped	2-0011190	SOLOMON POND RD	ROADWAY RELEASE - ACROSS FROM SUPER 8	DIESEL FUEL (100 GAL)	4/8/1996	ROADWAY	VEHICLE
Mapped	2-0011222	50A BRIGHAM ST	SAFETY KLEEN FACILITY	WASTE OIL	5/9/1996	COMMERCIAL	RRCAR
Not Mapped	2-0011240	RTE 290 E	1 MI E OF SOLOMON POND	DIESEL FUEL (20 GAL)	5/22/1996	ROADWAY	PIPE
Mapped	2-0011409	457 BOLTON ST	NAVIN SKATING RINK	METHANE, TRICHLOROFLUORO- (3500 LBS)	9/21/1996	STATE	REFRIGATN, SYSTEM
Not Mapped	2-0011414	DANGELO DR	BTWN CEDAR HILL ST AND FOREST ST	ASBESTOS	9/26/1996	OPENSPACE, ROADSIDE	2 BAGS OF, ASBESTOS
Mapped	2-0011445	146 MAPLE ST	BAKERLY CITGO-KING BRAKES	GASOLINE (2.5 INCH)	10/18/1996	COMMERCIAL	PIPE, UST
Mapped	2-0011486	413 LAKESIDE AVE	SHELL SERVICE STA	GASOLINE (.05 GAL/HR), GASOLINE (323 PPMV)	11/18/1996	COMMERCIAL	PIPE
Mapped	2-0011575	50A BRIGHAM ST	SAFETY KLEEN	SODIUM HYDROXIDE (95 GAL)	1/21/1997	COMMERCIAL	3 55 GAL, DRUMS
Mapped	2-0011648	RTE 290	AT RTE 495	DIESEL FUEL (100 GAL)	3/20/1997	ROADWAY	VEHICLE
Mapped	2-0011728	50A BRIGHAM ST	SAFETY KLEEN	AROMATIC SOLVENT (200 GAL), AROMATIC SOLVENT (392 GAL)	5/20/1997	COMMERCIAL	AST
Mapped	2-0011998	84 CHESTNUT ST	FRYE TANNER	OIL, UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL	7/28/1997	INDUSTRIAL	DRUMS, FORMER, OPERATIONS, TAN
Mapped	2-0011882	417 MAPLE ST	A&P TRANSPORTATION FACILITY	DIESEL FUEL (160 PPMV)	9/18/1997	COMMERCIAL	UST

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	2-0011887	247 MAPLE ST	COLONY GAS STA FMR	BENZO[A]PYRENE (1.54 MG/KG), DIBENZ[A,H]ANTHRACENE (2.11 MG/KG), GASOLINE (220 PPMV)	9/19/1997	COMMERCIAL	12K GAL, UST
Mapped	2-0011891	260 WEST MAIN ST	ROADWAY RELEASE	DIESEL FUEL (15 GAL)	9/19/1997	ROADWAY	VEHICLE
Mapped	2-0011955	1 EAST MAIN ST	CUMBERLAND FARMS	FUEL OIL #2 (234 PPMV)	10/31/1997	COMMERCIAL	UST
Mapped	2-0011964	50A BRIGHAM ST	SAFETY KLEEN	WASTE OIL (300 GAL)	11/7/1997	COMMERCIAL	TANKER
Not Mapped	2-0012042	RTE 495S	ROADWAY RELEASE	DIESEL FUEL (100 GAL)	12/19/1997	ROADWAY	VEHICLE
Mapped	2-0012190	CRANE MEADOW RD	RICH PRODUCTS CORP	AMMONIA (100 LBS), AMMONIA (50 LBS)	4/19/1998	COMMERCIAL	VALVE
Not Mapped	2-0012193	AMES ST	ROADWAY RELEASE	UNKNOWN CHEMICAL OF UNKNOWN TYPE (1 GAL)	4/22/1998	ROADWAY	1 GALLON, CONTAINER, PLASTIC
Mapped	2-0012207	PLEASANT ST	PERRY LANE	DIESEL FUEL (11 GAL)	5/3/1998	RESIDNTIAL, ROADWAY	VEHICLE
Mapped	2-0012419	19 MAPLE ST	INTERSECTION OF WARREN AVE	PROPANE, 2-METHOXY-2-METHYL- (1.4 PPM), TOTAL PETROLEUM HYDROCARBONS (TPH) (1200 PPM)	6/11/1998		
Mapped	2-0012274	415 MAPLE ST	VIGEANT COMMERCIAL PROPERTY	WASTE OIL (150 PPMV)	6/30/1998	COMMERCIAL, INDUSTRIAL	UST
Mapped	2-0012285	277 BOSTON POST RD	MAYFLOWER TRANSPORTATION	DIESEL FUEL (50 GAL)	7/2/1998	COMMERCIAL	VEHICLE
Mapped	2-0012376	50A BRIGHAM ST	SAFETY KLEEN	UNKNOWN CHEMICAL OF UNKNOWN TYPE (55 GAL)	8/31/1998	COMMERCIAL	DRUMS
Mapped	2-0012471	146 MAPLE ST	BAKERLY CITGO-KING BRAKES	GASOLINE	10/23/1998	COMMERCIAL	UST
Not Mapped	2-0012603	RTE 290 WESTBOUND	ROADWAY RELEASE	DIESEL FUEL (150 GAL)	1/15/1999	ROADWAY	VEHICLE
Mapped	2-0012632	146 MAPLE ST	BAKERLY CITGO-KING BRAKES	GASOLINE (10 GAL)	1/26/1999	COMMERCIAL	DISPENSER, GASOLINE
Mapped	2-0012629	85 HAYES MEMORIAL DR	DIAMOND MACHINING TECHNOLOGY INC	DIESEL FUEL (20 GAL)	1/26/1999	COMMERCIAL	PIPE
Mapped	2-0012695	150 CEDAR HILL ST	KENS FOODS		2/5/1999		
Not Mapped	2-0012696	BOSTON POST RD	M & M TRANSPORT CO	UNKNOWN CHEMICAL OF UNKNOWN TYPE (10 GAL)	3/9/1999	ROADWAY	VEHICLE
Mapped	2-0012726	301 MAPLE ST	T & W REALTY TRUST	TOTAL PETROLEUM HYDROCARBONS (TPH) (2.5 PPM)	3/24/1999	COMMERCIAL	UST
Mapped	2-0012780	146 MAPLE ST	BAKERLY CITGO-KING BRAKES	UNKNOWN CHEMICAL OF UNKNOWN TYPE	5/1/1999		GAS, PLUME
Mapped	2-0012648	301 MAPLE ST	T & W REALTY TRUST	ETHANE, 1,1,2,2-TETRACHLORO- (.639 MG/KG), ETHENE, CHLORO- (2 UG/L)	5/19/1999		
Mapped	2-0012797	686 STOW RD	FOSSILE CONSTRUCTION	DIESEL FUEL (30 GAL)	5/21/1999	ROADWAY	VEHICLE

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	2-0012883	50A BRIGHAM ST	SAFETY KLEEN	UNKNOWN CHEMICAL OF TYPE - OIL (9 GAL)	7/29/1999	COMMERCIAL	DRUMS
Mapped	2-0012912	RTE 290 EASTBOUND AT RTE 495	ROADWAY RELEASE	DIESEL FUEL (70 GAL)	8/25/1999	ROADWAY	VEHICLE
Mapped	2-0012945	2 BOSTON POST RD	FORMER TEXACO STA		9/14/1999		
Mapped	2-0012955	33 BOSTON POST RD W	JOHN HANCOCK MUTUAL LIFE INSURANCE CO	BENZENE, METHYL- (6690 UG/L), UNKNOWN CHEMICAL OF UNKNOWN TYPE (14.3 MG/KG)	9/28/1999		
Mapped	2-0012958	146 MAPLE ST	CITGO STA	WASTE OIL (10 GAL)	10/4/1999	COMMERCIAL	UST
Mapped	2-0012964	50A BRIGHAM ST	SAFETY KLEEN	UNKNOWN CHEMICAL OF TYPE - OIL (30 GAL)	10/4/1999		DRUMS
Mapped	2-0012985	146 MAPLE ST	BAKERLY CITGO KING BRAKES	FUEL OIL #2 (120 PPMV)	10/6/1999	COMMERCIAL	UST
Mapped	2-0012984	146 MAPLE ST	KING BRAKES	GASOLINE (300 PPMV)	10/15/1999	COMMERCIAL	
Mapped	2-0013031	771 BOSTON POST RD E	MARLBOROUGH COMMONS MALL	ETHENE, TETRACHLORO- (560 MG/KG)	11/16/1999	COMMERCIAL	
Not Mapped	2-0013110	RTE 495	RTE 495 S AT MM 65.5	DIESEL FUEL (50 GAL)	1/2/2000	ROADWAY	VEHICLE
Mapped	2-0013126	428 MAPLE ST	WAYSIDE FORD	ETHENE, TETRACHLORO- (.82 MG/KG)	1/13/2000		
Mapped	2-0013153	417 MAPLE ST	PREMIUM FUEL CORP	FUEL OIL #2 (20 GAL)	2/9/2000	COMMERCIAL	PIPE
Mapped	2-0013156	222 EAST MAIN ST	COMMERCIAL PROPERTY	ETHENE, CHLORO- (21 UG/L)	2/10/2000		
Not Mapped	2-0013172	HILDRETH ST	UTILITY POLE NO 1	UNKNOWN CHEMICAL OF UNKNOWN TYPE (20 GAL)	2/26/2000	MUNICIPAL, ROADWAY	TRANSFORM
Mapped	2-0013192	271 FARM RD	RESIDENCE	FUEL OIL #2 (100 GAL)	3/14/2000	RESIDNTIAL	AST
Mapped	2-0013193	55 FAIRBANKS BLVD	LUCENT TECHNOLOGIES	DIESEL FUEL (20 GAL)	3/15/2000	COMMERCIAL	AST
Not Mapped	2-0013286	WEST MAIN ST	PARCEL 27 COMMERCIAL PROPERTY	UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (63000 UG/L)	5/3/2000		
Mapped	2-0013333	193 BOSTON POST RD W	VICTORY SUPERMARKET	UNKNOWN CHEMICAL OF UNKNOWN TYPE (12 GAL)	6/20/2000	COMMERCIAL	PIPE
Mapped	2-0013575	656 BOSTON POST RD	STARRETT FAMILY TRUST		7/10/2000		
Not Mapped	2-0013392	BOSTON POST RD	ROADWAY RELEASE	DIESEL FUEL (20 GAL)	7/28/2000	ROADWAY	VEHICLE
Not Mapped	2-0013420	PROSPECT ST	UTILITY POLE NO 4-1	UNKNOWN CHEMICAL OF UNKNOWN TYPE (84 GAL)	8/8/2000		TRANSFORM
Not Mapped	2-0013427	BOUNDARY ST	MARLBOROUGH DPW	IRON CHLORIDE (FeC13) (119 GAL)	8/12/2000	MUNICIPAL	TANKER
Not Mapped	2-0013481	STEVENS ST	WATERS EDGE DEV	UNKNOWN CHEMICAL OF TYPE - OIL (10 GAL), UNKNOWN CHEMICAL OF UNKNOWN TYPE (20 GAL), UNKNOWN CHEMICAL OF UNKNOWN TYPE (4800 PPM)	9/19/2000	COMMERCIAL	VEHICLE

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Not Mapped	2-0013515	OFF CEDAR HILL RD	MWRA WALNUT HILL TREATMENT PLANT	BENZ[A]ANTHRACENE (1.45 PPM), BENZ[E]ACEPHENANTHRYLENE (.892 PPM), BENZO[A]PYRENE (1.24 PPM)	10/11/2000		
Mapped	2-0013531	50A BRIGHAM ST	SAFETY KLEEN	UNKNOWN CHEMICAL OF UNKNOWN TYPE	10/23/2000	COMMERCIAL	DRUMS
Mapped	2-0013554	299 MAPLE ST	JEMS OF NEW ENGLAND	TOTAL PETROLEUM HYDROCARBONS (TPH) (1500 MG/L)	11/7/2000		
Mapped	2-0013585	50 DANGELO DR	BFI INC	PETROLEUM BASED OIL (20 GAL)	12/1/2000	ROADWAY	VEHICLE
Not Mapped	2-0013590	EWALD AVE	LOT NO 31	DIESEL FUEL (10 GAL), PETROLEUM BASED OIL (10 GAL)	12/4/2000	RESIDNTIAL	VEHICLE
Mapped	2-0013603	265 LAKESIDE AVE	HOLIDAY INN PARKING LOT	GASOLINE (30 GAL)	12/11/2000	ROADWAY	PIPE, VEHICLE
Mapped	2-0013607	MAPLE ST AND MILL ST	RTE 85	UNKNOWN CHEMICAL OF UNKNOWN TYPE (20 GAL)	12/13/2000	ROADWAY	TRANSFORM
Mapped	2-0013690	222 EAST MAIN ST	KARNAK REALTY TRUST	ETHENE, TETRACHLORO- (.98 UG/L)	2/14/2001	COMMERCIAL	
Mapped	2-0013738	135 NEIL ST	MARLBOROUGH DPW	ARSENIC (410 MG/KG), NAPHTHALENE (17.6 MG/KG), UNKNOWN CHEMICAL OF UNKNOWN TYPE (6.46 MG/KG)	3/16/2001		
Mapped	2-0013746	65 LAKESHORE DR	FORT MEADOW LAKE	FUEL OIL #2 (125 GAL)	3/24/2001	RESIDNTIAL	AST
Mapped	2-0013773	100 PHELPS ST	TRAILER PARK LOT NO 31	FUEL OIL #2 (150 GAL)	4/8/2001	COMMERCIAL, RESIDNTIAL	AST
Mapped	2-0013796	164 BOSTON POST RD	MCDONALDS PARKING LOT	DIESEL FUEL (10 GAL)	4/27/2001	COMMERCIAL, ROADWAY	VEHICLE
Not Mapped	2-0013808	RTE 495	RTE 495 S NORTH OF RTE 290 ONRAMP	DIESEL FUEL (60 GAL)	5/11/2001	ROADWAY	VEHICLE
Mapped	2-0013844	81 BOSTON POST RD	WASTE MGMT INC	PETROLEUM BASED OIL (25 GAL)	6/11/2001	COMMERCIAL	PIPE
Mapped	2-0013859	50A BRIGHAM ST	SAFETY KLEEN SYSTEMS	UNKNOWN CHEMICAL OF UNKNOWN TYPE	6/18/2001		DRUMS
Mapped	2-0013900	114 EAST MAIN ST	FMR EXXON FACILITY NO 35030	NAPHTHALENE (8.6 MG/KG)	7/10/2001		
Mapped	2-0013950	50A BRIGHAM ST	SAFETY KLEEN SYSTEMS INC	2-PROPANONE, METHANE, TRICHLORO-	8/13/2001		DRUMS
Mapped	2-0013957	50A BRIGHAM ST	SAFETY KLEEN	UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (5 GAL)	8/21/2001	INDUSTRIAL	DRUMS
Mapped	2-0013965	GLEN ST AND RIPLEY ST	MILLHAM BROOK	UNKNOWN CHEMICAL OF UNKNOWN TYPE	8/30/2001	WATERBODY	UNKNOWN
Mapped	2-0014081	120 BARTLETT ST	BUTCHER CO	FUEL OIL #2 (18 INCH)	11/9/2001	INDUSTRIAL	

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	2-0014120	120 BARTLETT ST	THE BUTCHER COMPANY	FUEL OIL #2 (237 PPMV)	12/14/2001	COMMERCIAL	UST
Mapped	2-0014176	413 LAKESIDE AVE	SHELL STATION	UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (90.1 PPB)	2/4/2002	COMMERCIAL	SRM
Mapped	2-0014194	LAKESIDE AVE	NSTAR FRONT OF 175 LAKESIDE AVE	GASOLINE	2/15/2002	RIGHTOFWAY	UNKNOWN
Mapped	2-0014246	771 BOSTON POST RD	RK PINE TREE SHOPPING CTR	INDENO(1,2,3-CD)PYRENE (1.3 MG/KG), UNKNOWN CHEMICAL OF UNKNOWN TYPE (1.4 MG/KG), UNKNOWN CHEMICAL OF UNKNOWN TYPE (1.7 MG/KG), UNKNOWN CHEMICAL OF UNKNOWN TYPE (2.1 MG/KG)	3/26/2002		
Mapped	2-0014270	529 BOSTON POST RD	MOBIL FACILITY 01-794	BENZENE (35.3 UG/G), BENZENE, ETHYL- (140 UG/G), BENZENE, METHYL- (425 UG/G), NAPHTHALENE (32.9 UG/G), UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (267 UG/G), UNKNOWN CHEMICAL OF TYPE - OIL (555 UG/G)	4/10/2002		
Not Mapped	2-0014267	WEST MAIN ST	MOBIL CORP PARCEL 27 COMMERCIAL PROPERTY	UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (452 PPB)	4/12/2002	COMMERCIAL	UNKNOWN
Mapped	2-0014317	342 BOSTON POST RD	SHELL STATION	GASOLINE (.05 GAL/HR)	5/22/2002	COMMERCIAL	DFS10349, SUMP
Mapped	2-0014341	56 JEFFERSON ST	FMR B AND M TURNAROUND	LEAD (.056 MG/L), LEAD (450 MG/KG), UNKNOWN CHEMICAL OF UNKNOWN TYPE (50 MG/KG), UNKNOWN CHEMICAL OF UNKNOWN TYPE (9.4 MG/KG)	6/4/2002		
Mapped	2-0014385	123 FELTON ST	FELTON STREET ASSOCIATES	ETHENE, 1,1-DICHLORO- (20 UG/L)	7/3/2002		
Mapped	2-0014422	1 DANGELO DR	RR TRACKS		8/6/2002		
Mapped	2-0014434	260 WEST MAIN ST	MOBIL STATION	UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (100000 UG/L)	8/12/2002		
Mapped	2-0014439	45 BARTLETT ST	ARM FACILITY	ETHENE, CHLORO- (1 LBS), UNKNOWN CHEMICAL OF TYPE - OIL (55 GAL)	8/14/2002	INDUSTRIAL	DRUMS
Mapped	2-0014514	509 LINCOLN ST	LINCOLN MARLBOROUGH TRUST	ARSENIC (140 MG/KG), LEAD (940 MG/KG)	10/9/2002		

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	2-0014560	146 MAPLE ST	KING BRAKES	BENZENE, DIMETHYL (5.8 UG/L), BENZENE, ETHYL- (4.1 UG/L), UNKNOWN CHEMICAL OF TYPE - HAZARDOUS MATERIAL (370 UG/L)	11/20/2002	COMMERCIAL	UST
Mapped	2-0014592	749 DONALD LYNCH BLVD	UPPER RIVER ROAD LLC	FUEL OIL #2 (1800 MG/KG), TOTAL PETROLEUM HYDROCARBONS (TPH) (1800 PPM)	12/17/2002	COMMERCIAL	UNKNOWN
Mapped	C90-0798	102 HAYES MEMORIAL DR	AIR PRODUCTS	GASOLINE			U.S.T.
Mapped	C86-0074	146 MAPLE ST	AT & T	OTHER MATERIAL, OIL CONTAMINATED WATER (UNK)			OTHER SOURCE, AT& T MANHOLE
Mapped	C87-0456	175 MAPLE ST	DESIGN PAK	OTHER MATERIAL, OIL (10-50 GAL)			DRUM
Mapped	C89-0251	201 BROAD ST		WASTE OIL			OTHER SOURCE, UNKNOWN
Mapped	C89-0616	21 EAST MAIN ST	MARLBOROUGH GARAGE	GASOLINE			U.S.T.
Mapped	C90-0332	214 CEDARHILL RD	MASS TRANSPORT INC	OTHER MATERIAL, WASTE OIL & MASONERY ACID			DRUM
Mapped	C92-0306	225 BOSTON POST RD	CHARLES CHEVROLET	WASTE OIL (UNK)			U.S.T.
Mapped	C87-0403	23 EAGER COURT		WASTE OIL			OTHER SOURCE, CAR MOTOR OIL
Mapped	C86-0210	247 MAPLE ST	ABANDONED UST	GASOLINE (UNK GAL)			U.S.T.
Mapped	C90-0513	250 LOCK DR	JOHN HANCOCK INS. CO.	#2 FUEL OIL (UNK GAL)			U.S.T.
Mapped	C90-0379	299 MAPLE ST	LANDS TOWING/MARANE OIL	GASOLINE (UNK)			U.S.T.
Mapped	C85-0029	3 BELLVIEW DR, PORAS RESID.	#2 OIL SPILL AT RESIDENCE	#2 FUEL OIL (251-500 GAL)			ABOVE-GRND TANK
Mapped	C92-0053	3 RESULTS WAY	DIGITAL EQUIPMENT CORP.	OTHER MATERIAL, #2 OIL CONTAMINATED SOIL (UNK CUBIC YDS)			U.S.T.
Mapped	C90-0663	308 LINCOLN ST	CAR BATTERY DUMPING	BATTERIES/BATTERY ACID (UNK)			OTHER SOURCE, UNKNOWN
Mapped	C88-0333	424 LINCOLN ST		WASTE OIL			DRUM
Mapped	C90-0222	431 LINCOLN ST	SHELL OIL	OTHER MATERIAL, GASOLINE CONT. SOIL			OTHER SOURCE, STAGE 2 VAPOR
Mapped	C93-0426	46 REYNOLDS ST	POSSIBLE RESIDENCIAL DUMPING	OTHER MATERIAL, CONSTRUCTION DEBRIS (UNK GAL)			OTHER SOURCE, DEMOLITION DEBR
Mapped	C90-0140	48 WELLINGTON	RUPTURED FUEL TANK	#2 FUEL OIL			ABOVE-GRND TANK
Not Mapped	C88-0354	495 OVERPASS		GASOLINE (51-100 GAL)			

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Mapped	C93-0210	496 LINCOLN ST	MOTOR OIL DUMPING	MOTOR OIL (UNK GAL)			OTHER SOURCE, VEHICLE
Mapped	C87-0195	50 MAIN ST	MOBIL STATION	GASOLINE			U.S.T.
Mapped	C90-0348	50 MAIN ST	DRAKE PETROLEUM	GASOLINE			U.S.T.
Mapped	C93-0214	50A BRIGHAM ST	SAFETY CLEAN	OTHER MATERIAL, NAPTHALENE (UNK GAL)			DRUM
Mapped	C88-0661	547 BOSTON POST RD		MISCELLANEOUS OIL (10-50 GAL)			ABOVE-GRND TANK
Mapped	C89-0453	61 BRIGHAM RD	SUPERIOR PRINTING	OTHER MATERIAL, INK,PAINT,VARNISH (UNK)			OTHER SOURCE, SPRINK. FLOOD
Mapped	C90-0443	615 WILLIAM ST	RESIDENT FUEL OIL TANK LEAK	#2 FUEL OIL			ABOVE-GRND TANK
Mapped	C87-0397	656 BOSTON POST RD	STARRETT PAVING	GASOLINE			U.S.T.
Mapped	C93-0180	69 SECOND RD	69 SECOND RD	OTHER MATERIAL, NOT SPECIFIED (< 1 GAL)			
Mapped	C88-0617	720 BOSTON POST RD		#2 FUEL OIL			U.S.T.
Not Mapped	C89-0203	770 OLD POST RD	RT. 20	GASOLINE (UNK)			U.S.T.
Mapped	C87-0466	82 FLORENCE ST	MASS ELECTRIC	DIESEL FUEL (UNK)			U.S.T.
Mapped	C92-0182	98 HOME ST	TELEPHONE POLE #11	OTHER MATERIAL, CREOSOTE (UNK)			OTHER SOURCE, TELEPHONE POLE
Mapped	C83-0129	BOLTON & LINCOLN ST	SUNOCO STATION	GASOLINE (UNK)			U.S.T.
Not Mapped	C89-0753	EAST MAIN ST	EXXON STATION	GASOLINE			U.S.T.
Not Mapped	C88-0360	ELM ST		#2 FUEL OIL			
Not Mapped	C85-0244	FLORENCE ST, #82	MASS. ELECTRIC CO.	#2 FUEL OIL (UNK GAL)			U.S.T.
Not Mapped	C89-0550	HAYES MEMORIAL DR	MASS ELECTRIC POLE #22	TRANSFORMER OIL (10-50 UNK)			OTHER SOURCE, LINE RECLOSER
Mapped	C86-0389	M.D.C. PROP.,WALKER ST& RT 85	M.D.C. PROPERTY	WASTE OIL (UNK)			OTHER SOURCE, UNKNOWN
Not Mapped	C87-0323	MAIN ST IN PARKING LOT OFF	FLORENCE ST	MISCELLANEOUS OIL			OTHER SOURCE, UNKNOWN
Mapped	C90-0315	MAPLE & HARVARD ST	N.E. TELEPHONE MANHOLE	GASOLINE (UNK)			OTHER SOURCE, UNKNOWN
Not Mapped	C85-0071	MARLBORO BROOK	OIL DISCHARGE TO BROOK	MISCELLANEOUS OIL (UNK GAL)			OTHER SOURCE, UNKNOWN
Not Mapped	C85-0125	MARLBORO INDUSTRIAL PARK	J. HANCOCK INS CO.	DIESEL FUEL (UNK)			U.S.T.
Not Mapped	C92-0055	MDC POND, ON MAPLE ST	CHRONIC SHEEN FROM EMBANKMENT	OTHER MATERIAL, SHEEN ON BROOK (SHEEN)			
Mapped	C89-0663	NEIL ST	CITY OF MARLBOROUGH	GASOLINE (UNK)			U.S.T.

Table 17 (cont.) - Environmental Release and Spill Sites in Marlborough, MA

MAPPED/NOT MAPPED	ID	ADDRESS	LOCATION AID	MATERIALS	NOTIFICATION DATE	LOCATION TYPE	SOURCE
Not Mapped	C92-0138	ON ROADSIDE	ROOF WASH AND BATTERIES	OTHER MATERIAL, ROOF WASH AND 2 BATTERIES (UNK GAL)			
Not Mapped	C93-0164	PLEASANT ST AREA	GAS IN STORM DRAIN	GASOLINE (UNK GAL)			
Not Mapped	C85-0189	REINGOLD ST	UNKNOWN DUMPING	OTHER MATERIAL, MOTOR OIL AND GASOLINE (UNK GAL)			
Mapped	C88-0384	RT 20 AND PETERS AVE		GASOLINE (10-50 GAL)			VEH. FUEL TANK
Mapped	C88-0388	RTE 20 & HAYES MEM. DR		GASOLINE (1-10 GAL)			VEH. FUEL TANK
Mapped	C92-0360	RTE. 20 & CONCORD	PESTICIDE SPRAYING	OTHER MATERIAL, PESTICIDE (UNK)			
Not Mapped	C91-0064	WAYSIDE INN RD	DRUM OF WASTE OIL LEAKING	WASTE OIL (DRUM)			DRUM
Not Mapped	C89-0050	WILSON ST	SISTERS OF GOOD SHEPARD	#6 FUEL OIL (UNK)			ABOVE-GRND TANK
Not Mapped	C89-0317		LEAD ARSENITE COMTAMINATION	OTHER MATERIAL, LEAD ARSENITE (UNK)			OTHER SOURCE, FMR APPLE ORCH.

[1] If a site that was identified prior to 1993 had not been closed out (i.e., its cleanup was not complete) by 1993, then it was carried forward into the new 21E database that was designed by the Bureau of Waste Site Cleanup in 1993.

Data Source: Massachusetts Department of Environmental Protection. Bureau of Waste Site Cleanup 21E Sites Database (http://www.mass.gov/dep/cleanup/sites/sdown.htm). Information contained in this table is presented as downloaded. [Cited June 2001, July 2001, February 2002 and May 2006]

Notes:
Mapped/Not Mapped - Refers to if address information was sufficient to allow for mapping
ID - Identification number assigned to the spill/release.
Location Aid - Additional information regarding the location of the spill
Notification Date - Date MDEP was notified of the contamination
Materials - Information regarding the specific chemicals (and amounts) found at the site

APPENDIX A
Risk Factor Information for Leukemia, Liver Cancer, and Lung Cancer

Risk Factor Information for Leukemia

Leukemia is the general term that includes a group of different cancers that occur in the blood forming organs and result in the formation of abnormal amounts and types of white blood cells in the blood and bone marrow. Individuals with leukemia generally maintain abnormally high amounts of leukocytes or white blood cells in their blood. This condition results in an individual's inability to maintain certain body functions, particularly a person's ability to combat infection.

In 2006, leukemia is expected to affect approximately 35,070 individuals in the United States (20,000 males and 16,730 females) in the United States, resulting in 22,280 deaths. Acute cases of leukemia are slightly more common that chronic, 15,860 and 14,520 respectively. In Massachusetts, approximately 770 individuals will be diagnosed with the disease in 2006, representing more than 2% of all cancer diagnoses. There are four major types of leukemia: acute lymphoid leukemia (ALL), acute myeloid leukemia (AML), chronic lymphoid leukemia (CLL), and chronic myeloid leukemia (CML). There are also a few rare types, such as hairy cell leukemia. In adults, the most common types are AML (approximately 11,700 cases) and CLL (approximately 9,560 cases). Incidences of ALL have increased approximately 1.8% per year since 1988 while incidences of CLL have decreased approximately 1.9% each year since 1988. Leukemia is the most common type of childhood cancer, accounting for about 30% of all cancers diagnosed in children. The majority (74%) of these cases are of the ALL type (ACS, 2006a).

While ALL occurs predominantly among children (peaking between ages 2 and 3 years), an elevation in incidence is also seen among older individuals, and 1300 (one-third) of total cases of ALL will occur in adults. ALL risk is lowest for adults aged 25 through 50 and then begins to pick up (ACS, 2006b). The increase in incidence among older individuals begins at approximately 40-50 years of age, peaking at about age 85 (Linet and Cartwright, 1996). ALL is more common among whites than African Americans and among males than females (Weinstein and Tarbell, 1997). Exposure to high-dose radiation (e.g., by survivors of atomic bomb blasts or nuclear reactor accidents) is a known environmental risk factor associated with the development of ALL (ACS, 2006b). Significant radiation exposure (e.g., diagnostic x-rays) within the first few months of development may carry up to a 5-fold increased risk of developing ALL (ACS, 2006b). However, few studies report an increased risk of leukemia associated with residing in proximity to nuclear plants or occupational exposure to low-dose radiation (Linet and Cartwright, 1996; Scheinberg et al., 1997). There is conflicting evidence about whether exposure to electromagnetic fields (EMF) plays a role in the development of ALL, however, most studies to date have found little or no risk (ACS, 2006b).

Few other risk factors for ALL have been identified. There is evidence that genetics may play an important role in the development of this leukemia type. Studies indicate that siblings of twins who develop leukemia are at an increased risk of developing the disease. Children with Down's syndrome are 10 to 20 times more likely to develop acute leukemia (Weinstein and Tarbell, 1997). In addition, other genetic diseases, such as Li-Fraumeni syndrome and Klinefelter's syndrome, are associated with an increased risk of developing leukemia. Patients receiving medication that suppresses the immune system (e.g., organ transplant patients) may be more likely to develop ALL (ACS, 2006c). ALL has not been definitively linked to chemical exposure, however, childhood ALL may be associated with maternal occupational exposure to pesticides during pregnancy (Infante-Rivard et al., 1999). Certain rare types of adult ALL are caused by human T-cell leukemia/lymphoma virus-I (HTLV-I) (ACS, 2006c). Some reports have linked other viruses with various types of leukemia, including Epstein-Barr virus and hepatitis B virus. Still others propose that leukemia may develop as a response to viral infection. However, no specific virus has been identified as related to ALL (Linet and Cartwright, 1996). Reports also suggest an infectious etiology for some childhood ALL cases, although a specific viral agent has

not been identified and findings from studies exploring contact among children in day-care do not support this hypothesis (Greaves MF, 1997; Kinlen and Balkwill, 2001; Rosenbaum et al., 2000).

Although AML can occur in children (usually during the first two years of life), AML is the most common leukemia among adults, with an average age at diagnosis of 65 years (ACS, 2006d). This type of leukemia is more common among males than among females but affects African Americans and whites at similar rates (Scheinberg et al., 1997). High-dose radiation exposure (e.g., by survivors of atomic bomb blasts or nuclear reactor accidents), long-term occupational exposure to benzene (a chemical in gasoline and cigarette smoke), and exposure to certain chemotherapy drugs, especially alkylating agents (e.g., mechlorethamine, cyclophosphamide), have been associated with an increased risk of developing AML among both children and adults (ACS, 2006d). The development of childhood AML is suspected to be related to parental exposure to pesticides and other chemicals, although findings are inconsistent (Linet and Cartwright, 1996). Studies have suggested a link between electromagnetic field (EMF) exposure (e.g., from power lines) and leukemia (Minder and Pfluger, 2001; Schuz et al., 2001). However, there is conflicting evidence regarding EMF exposure and leukemia and it is clear that most cases are not related to EMF (Kleinerman et al., 2000).

Other possible risk factors related to the development of AML include cigarette smoking and genetic disorders. It is estimated that approximately one-fifth of cases of AML are caused by smoking (Scheinberg et al., 1997). Also, a small number of AML cases can be attributed to rare inherited disorders, such as Down's syndrome (ACS, 2006d). Recently, scientists have suggested that a mutation in a gene responsible for the deactivation of certain toxic metabolites may have the ability to increase the risk of acute myeloid leukemia in adults. However, further research is necessary in order to confirm the findings of this study (Smith et al., 2001).

CLL is chiefly an adult disease; the average age at diagnosis is about 70 years (ACS, 2006e). Twice as many men as women are affected by this type of leukemia (Deisseroth et al., 1997). While genetics and diseases of the immune system have been suggested as playing a role in the development of CLL, high-dose radiation and benzene exposure have not (ACS, 1999; Weinstein and Tarbell, 1997). It is thought that individuals with a family history of CLL are two to four times as likely to develop the disease. Some studies have identified an increased risk of developing CLL (as well as ALL, AML, and CML) among farmers due to long-term exposure to herbicides and/or pesticides (Linet and Cartwright, 1996). Although viruses have been implicated in the etiology of other leukemias, there is no evidence that viruses cause CLL (Deisseroth et al., 1997).

Of all the leukemias, CML is among the least understood. While this disease can occur at any age, CML is extremely rare in children (about 2% of leukemias in children) and the average age of diagnosis is 40 to 50 years (ACS, 2006f). Incidence rates are higher in males than in females, but unlike the other leukemia types, rates are higher in blacks than in whites in the U.S. (Linet and Cartwright, 1996). High-dose radiation exposure may increase the risk of developing CML (ACS, 2006f). Finally, CML has been associated with chromosome abnormalities such as the Philadelphia chromosome (Weinstein and Tarbell, 1997).

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Risk Factor Information for Liver Cancer

An estimated 18,510 people in the U.S. (12,600 men and 5,910 women) will be diagnosed with liver and intrahepatic bile duct cancer in 2006, accounting for approximately 1% of all new cancers (ACS 2006). Hepatocellular carcinoma (HCC) is the most common primary cancer of the liver and accounts for about 75% of all cases. Rarer forms of malignant liver cancer include the fibrolamellar subtype of HCC, cholangiocarcinoma, and angiosarcomain adults and hepatoblastoma in children. Cholangriocarcinomas account for approximately 10% to 20% of all primary liver cancers and people with gallstones, gall bladder inflammation, chronic ulcerative colitis (long-standing inflammation of the large bowel) or chronic infection with certain types of parasitic worms are at an increased risk for developing this cancer. Hepatoblastoma is a rare cancer that forms usually in children under age 4 and has a 90% survival rate with early detection (ACS 2006a).

In some developing countries, HCC is most common type of cancer diagnosed particularly in East Asia and Africa. Incidence in the United States had been increasing up to 1999. Recently, the rate has become more stable (ACS 2006a). Rates of HCC in the U.S. had increased by 70% during the 1980s and 1990s (Yu et al. 2000). Similar trends were observed in Canada and Western Europe. The primary reason for the higher rates observed during those years was the increase in hepatitis C virus infection, an important factor related to liver cancer (El-Serag 2001; El-Serag and Mason 2000).

Men are at least three times more likely to develop HCC than women. Much of this is likely due to differences in lifestyle factors which increase a person's risk for developing liver cancer (ACS 2006a). Although 85% of individuals diagnosed with liver cancer are between 45 and 85 years of age, the disease can occur in persons of any age (ACS 2006a).

Several important risk factors for liver cancer have been identified. Chronic infection with hepatitis B virus (HBV) and hepatitis C virus (HCV) are the most significant risk factors for developing liver cancer (ACS 2006a). It is estimated that 80% of HCC cases worldwide can be attributed to HBV infection (Yu et al. 2000). In the United States, HBV accounts for less than a quarter of the cases and infection with HCV plays a much larger role in the incidence of this cancer. HBV and HCV can be spread through intravenous drug use (e.g., the sharing of contaminated needles), unprotected sexual intercourse, and transfusion of and contact with unscreened blood and blood products. In addition, mothers who are infected with these viruses can pass them on to their children at birth or in early infancy (ACS 2006a).

Cirrhosis is also a major risk factor for the development of liver cancer. Cirrhosis is a progressive disease that is the result of scar tissue formation on the liver, which can lead to cancer. Researchers estimate that 60% to 80% of HCC cases are associated with cirrhosis. However, it is unclear if cirrhosis itself causes liver cancer or if the underlying causes of cirrhosis contribute to the development of this disease (Garr et al. 1997). Most liver cirrhosis in the U.S. occurs as a result of chronic alcohol abuse, but HBV and HCV are also major causes of cirrhosis (ACS 2006a). In addition, certain inherited metabolic diseases, such as hemochromatosis, which causes excess iron accumulation in the body, can lead to cirrhosis (ACS 2006a). Some studies have shown that people with hemochromatosis are at an increased risk of developing liver cancer (Fracanzani et al. 2001).

Epidemiological and environmental evidence indicates that exposure to certain chemicals and toxins can also contribute significantly to the development of liver cancer. For example, chronic consumption of alcoholic beverages has been associated with liver cancer (Wogan 2000). As noted above, it is unclear if alcohol itself causes HCC or if underlying cirrhosis is the cause (London and McGlynn 1996). However, it is clear that alcohol abuse can accelerate liver disease

and may act as a co-carcinogen in the development of liver cancer (Ince and Wands 1999). Long-term exposure to aflatoxin can also cause liver cancer. Aflatoxins are carcinogenic agents produced by a fungus found in tropical and subtropical regions. Individuals may be exposed to aflatoxins if they consume contaminated peanuts and other foods that have been stored under hot, humid conditions (Wogan 2000). Vinyl chloride, a known human carcinogen used in the manufacturing of some plastics, and thorium dioxide, used in the past for certain x-ray tests, are risk factors for a rare type of liver cancer called angiosarcoma (ACS 2006a; London and McGlynn 1996). These chemicals may also increase the risk of cholangiocarcinoma and HCC, but to a lesser degree. The impact of both thorium dioxide and vinyl chloride on the incidence of liver cancer was much greater in the past, since thorium dioxide has not been used for decades and exposure of workers to vinyl chloride is now strictly regulated in the U.S. (ACS 2006a). Drinking water contaminated with arsenic may increase the risk of liver cancer in some parts of the world (ACS 2006a; ATSDR 2001).

The use of oral contraceptives by women may also be a risk factor in the development of liver cancer. However, most of the studies linking oral contraceptives and HCC involved types of oral contraceptives that are no longer used. There is some indication that the increased risk may be confined to oral contraceptives containing mestranol. It is not known if the newer oral contraceptives, which contain different types and doses of estrogen and different combinations of estrogen with other hormones, significantly increase the risk of HCC (ACS 2006a; London and McGlynn 1996). Long-term anabolic steroid use may slightly increase the risk of HCC (ACS 2006a). Although many researchers believe that cigarette smoking plays a role in the development of liver cancer, the evidence for this is still inconclusive (Mizoue et al. 2000; London and McGlynn 1996).

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Lung cancer generally arises in the epithelial tissue of the lung. Several different histologic or cell types of lung cancer have been observed. The various types of lung cancer occur in different regions of the lung and each type is associated with slightly different risk factors (Blot and Fraumeni 1996). The most common type of lung cancer in the United States today is adenocarcinoma which accounts for about 40% of all lung cancers (ACS 2005). The greatest established risk factor for all types of lung cancer is cigarette smoking, followed by occupational and environmental exposures.

The incidence of lung cancer increases sharply with age peaking at about age 60 or 70. Lung cancer is very rare in people under the age of 40. The incidence is greater among men than women (probably because men are more likely to be smokers than women) and among blacks than whites (Blot and Fraumeni 1996). The American Cancer Society estimates that lung and bronchus cancer will be diagnosed in 174,470 people (92,700 cases in men and 81,770 in women) in the U.S. in 2006, accounting for about 12% of all new cancer diagnoses. For purposes of treatment, lung cancer is divided into two clinical groups: small cell lung cancer (13%) and non-small cell lung cancer (87%) (ACS 2006). Lung cancer is the leading cause of cancer death among both men and women; more people die of lung cancer than of colon, breast, and prostate cancers combined (ACS 2005). In Massachusetts, an estimated 4,070 individuals will be diagnosed with lung and bronchus cancer in 2006. Incidence rates for lung and bronchus cancer in Massachusetts from 1998 through 2002 were 86.5 per 100,000 and 60.4 per 100,000 for males and females, respectively (ACS 2006). Nationwide, the incidence rate declined significantly in men during the 1990s, most likely as a result of decreased smoking rates over the past 30 years. Rates for women are approaching a plateau, after a long period of increase. This is likely because decreasing smoking patterns among women have lagged behind those of men (ACS 2006). Trends in lung cancer incidence suggest that the disease has become increasingly associated with populations of lower socioeconomic status, since these individuals have higher rates of smoking than individuals of other groups (Blot and Fraumeni 1996).

Approximately 87% of all lung cancers are caused directly by smoking cigarettes and some of the rest are due to exposure to second hand smoke, or environmental tobacco smoke. The longer a person has been smoking and the higher the number of cigarettes smoked per day, the greater the risk of lung cancer. Smoking cessation decreases the elevated risk and ten years after smoking cessation the risk is reduced by one-third of what it would have been had smoking continued. However, former smokers still carry a greater risk than those who have never smoked. There is no evidence that smoking low tar or "light" cigarettes reduces the risk of lung cancer and mentholated cigarettes are thought to increase the risk of lung cancer. Additionally, breathing secondhand smoke also increases an individual's risk of developing lung cancer. A nonsmoking spouse of a smoker has a 30% greater risk of developing lung cancer than the spouse of a nonsmoker (ACS 2005).

Workplace exposures have also been identified as playing important roles in the development of lung cancer. Occupational exposure to asbestos is an established risk factor for this disease; asbestos workers are about seven times more likely to die from

lung cancer than the general population (ACS 2005). Underground miners exposed to radon and uranium are at an increased risk for developing lung cancer (Samet and Eradze 2000). Chemical workers, talc miners and millers, paper and pulp workers, carpenters, metal workers, butchers and meat packers, vineyard workers, carpenters and painters, and shipyard and railroad manufacture workers are some of the occupations associated with an increased risk of lung cancer (Blot and Fraumeni 1996; Pohlabeln et al. 2000). In addition to asbestos and radon, chemical compounds such as arsenic, chloromethyl ethers, chromium, vinyl chloride, nickel chromates, coal products, mustard gas, ionizing radiation, and fuels such as gasoline are also occupational risk factors for lung cancer (ACS 2005; Blot and Fraumeni 1996). Industrial sand workers exposed to crystalline silica are also at an increased risk for lung cancer (Rice et al. 2001; Steenland and Sanderson 2001). Occupational exposure to the compounds noted above in conjunction with cigarette smoking dramatically increases the risk of developing lung cancer (Blot and Fraumeni 1996).

As noted above, exposure to radon (a naturally occurring radioactive gas produced by the breakdown of radium and uranium) has been associated with increased risk of developing lung cancer among miners. Recently, a number of studies have demonstrated that exposure to elevated levels of residential radon may also increase lung cancer risk (Lubin and Boice 1997; Kreienbrock et al. 2001; Tomasek et al. 2001). Epidemiological evidence suggests that radon may be the second leading cause of lung cancer after smoking (Samet and Eradze 2000). However, actual lung cancer risk is determined by cumulative lifetime exposure to indoor radon. Therefore, normal patterns of residential mobility suggest that most people living in high-radon homes experience lifetime exposures equivalent to residing in homes with lower radon levels (Warner et al. 1996).

Some types of pneumonia may increase the risk of lung cancer due to scarred lung tissue (ACS 2002). In addition, people who have had lung cancer have a higher risk of developing another tumor. A family history of lung cancer also increases an individual's risk this is due to an abnormality on chromosome 6 (ACS 2005).

Air pollution may increase the risk of developing lung cancer in some cities. However, this risk is much lower than that due to cigarette smoking (ACS 2005).

Diet has also been implicated in the etiology of lung cancer, however, the exact relationship is unclear. Diets high in fruits and vegetables decrease lung cancer risk, but the reasons for this are unknown (Brownson et al. 1998). A study showed a positive association between total fat, monounsaturated fat, and saturated fat and lung cancer among males, however, this effect was not observed among women (Bandera et al. 1997).

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