Health Consultation
Assessment of Cancer Incidence and Exposure Opportunities from the Former Dow Chemical Site in Wayland, MA 1982 - 1994, 1995

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I. SUMMARY/BACKGROUND

In response to a request by the Wayland Board of Health, the Community Assessment Unit (CAU) of the Massachusetts Department of Public Health, Bureau of Environmental Health Assessment (MDPH/BEHA) conducted an investigation of cancer incidence in the town of Wayland and the potential for possible exposures to chemicals originating from the former Dow Chemical site located at 412 Commonwealth Road.

In response to these concerns, the MDPH conducted a descriptive epidemiological study of cancer incidence for the town of Wayland as a whole and for each of it's two census tracts. The MDPH also reviewed available environmental information and sampling data for the former Dow site to determine if local residents may have been exposed to chemicals originating from the site.

In June 1997, the MDPH, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), completed a Health Consultation entitled, *Assessment of Cancer Incidence in Wayland, Massachusetts, 1982-1992* (MDPH 1997a). This Consultation was released for public comment in June and the public comment period ended in December 1997.

This investigation concluded the following results:

- all cancer types investigated occurred approximately equal to or slightly greater than the expected rates;
- cancer incidence in the area of the Dow Chemical site generally occurred less often than expected;
- no unusual geographic pattern of cancer cases was observed for any of the cancer types evaluated; and
- based on the health outcome data reviewed and evaluation of exposure pathways, it seemed unlikely that an environmental factor (specifically, contamination associated with the Dow site) was responsible for the development of cancer in Wayland.

During the public comment period the MDPH received a number of comments and requests from the community for a continued follow-up investigation. In response to requests received during the public comment period, the MDPH analyzed and evaluated three additional years of cancer incidence data. As a result, this final Health Consultation includes cancer incidence data for the years 1982-1992, 1987-1994 and 1995. The MDPH also conducted further analyses regarding risk factor information for relevant cancer types described in this report, and reviewed the most recent environmental information and sampling data for the former Dow Chemical site.

II. INTRODUCTION

In response to a request by the Wayland Board of Health, the Community Assessment Unit (CAU) of the Massachusetts Department of Public Health, Bureau of Environmental Health Assessment (MDPH/BEHA) conducted an investigation of cancer incidence in the town of Wayland. In addition, the New England Development (NED)/Dow Neighbors, Inc., a group of citizens in Wayland, have expressed concerns that certain cancer types were possibly elevated in their neighborhood or in the town as a whole. The community was specifically concerned about possible exposures to chemicals originating from the former Dow Chemical site located at 412 Commonwealth Road. According to the 1990 census, the town of Wayland is divided into two smaller geographic areas or census tracts. The Dow Chemical site is located in census tract (CT) 3661. Refer to Figure 1 for census tract locations in Wayland.

In response to these concerns, the MDPH conducted a descriptive epidemiological study of cancer incidence for the town of Wayland as a whole and for each of it's two census tracts. The MDPH also reviewed available environmental information and sampling data for the former Dow site to determine if local residents may have been exposed to chemicals originating from the site.

It should be noted that the scope of this investigation was to evaluate cancer incidence in relation to concerns raised about the former Dow site. While the NED/Dow Neighbors, Inc. have also expressed concerns about the occurrence of non-cancer health outcomes (such as autoimmune
diseases and adverse reproductive outcomes) in Wayland, such an investigation is not possible

because unlike cancer, these outcomes are not reportable. As a result, this investigation will address cancer incidence only. This report is not a comprehensive evaluation of the environmental investigations that have taken place at the former Dow site, nor is this report a comprehensive evaluation of all health outcomes.

This report is a preliminary investigation that analyzes routinely collected descriptive health outcome data to determine whether the occurrence of selected cancers is unusual and that considers the potential for exposure to chemicals associated with the Dow site. Information from such descriptive analyses can be useful in determining whether or not a common etiology (or cause) of cancers is possible and can serve to identify areas where further public health investigations or actions may be warranted. Such actions may include follow-up environmental investigations or, when an excess of well-established risk factors associated with a disease in a certain geographic area have been identified (i.e., cancer screening, smoking cessation, etc.). The purpose of this evaluation is to report our findings for cancer incidence and discuss them in the context of the available information to determine whether recommendations for follow-up are warranted.

III. METHODS FOR ANALYZING CANCER INCIDENCE DATA

A. Case Identification

The observed number of cancer cases in this evaluation was derived from cases reported to the Massachusetts Cancer Registry (MCR) as primary site cancer cases diagnosed in Wayland residents during 1982 through 1995. Cases were selected for inclusion based on the address reported to the hospital or reporting facility at the time of diagnosis.

The MCR began collecting information on Massachusetts residents diagnosed with cancer in the state in 1982. All newly diagnosed cancer cases are required by law to be reported to the MCR within six months of the date of diagnosis (M.G.L.c.111s.111B). The 14-year period 1982-1995 constitutes the period for which the most recent and complete cancer incidence data were available at the time of this analysis.

The term "cancer" is used to describe a variety of diseases associated with abnormal cell and tissue growth. Primary site (location in the body where the disease originated) and histology (tissue or cell type) classify the different cancer types. Epidemiological studies have revealed that different types of cancer are individual diseases with separate causes, risk factors, characteristics and patterns of survival (Bang 1996).

Ten types of cancer were evaluated in this investigation. These include cancers of the bladder, breast, kidney, liver, lung (including bronchus), pancreas, and stomach, as well as Hodgkin's disease, non-Hodgkin's lymphoma (NHL) and leukemia. These cancer types were selected in order to address concerns expressed by residents of Wayland regarding suspected elevations in the incidence of these cancer types.

Only primary site cancers were included in this evaluation. Cancers that occur as the result of the metastases or the spread of a primary site cancer to another location in the body are not considered as a separate cancer and therefore, were not included. It should be noted that in 1992 the MCR began collecting data on cancers categorized as in situ cancers. In situ

cancers are malignant cells in the earliest stages of development, which do not always progress to invasive cancers. Since the public comment release, the BEHA no longer includes in situ cancers in cancer incidence evaluations because these data are not complete and are only available since 1992. Therefore, although in situ cancers were included in the previous evaluation (1982-1992), they have not been included in the analysis of more recent cancer incidence data (1987-1994, 1995). It should also be noted that the omission of in situ cancers only affects one cancer type, bladder cancer, resulting in one less observed case for the time period 1987-1994.

Occasionally, the MCR research file may contain duplicate cases. The data discussed in this report have been controlled for duplicate cases by excluding them from the analyses. However, reports of multiple primary site cancer cases were included. Duplicate cases are additional reports of the same primary site cancer case. A multiple primary cancer case is defined by the MCR as a new tumor of the same histology (original location in the body) more than two months after the initial diagnosis (MCR 1996). The determination that a case was a duplicate and should be excluded from the

analyses was made by the MCR after consulting with the hospital or reporting facilities and obtaining additional information regarding the histology and/or pathology of the case.

B. Calculation of Standardized Incidence Ratios (SIRs)

To determine whether elevated numbers of cancer cases have occurred in Wayland or its census tracts, cancer incidence data were analyzed by age 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 period 1982-1994 for each of the ten cancer types for the two CTs and the town as a whole. SIRs were also calculated for the three time periods 1982-1986, 1987-1992 and 1987-1994 in order to evaluate temporal trends in cancer incidence.

An SIR is an estimate of the occurrence of disease in a population in relation to what might be expected if the population in question had the same cancer experience as some

larger population designated as the comparison population. 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. 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.

Specifically, an SIR is the ratio of the observed number of cancer cases to the expected number of cases multiplied by 100. An SIR of 100 indicates that the number of cancer cases observed in the population 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 and an SIR less than 100 indicates that fewer cancer cases occurred than expected. Accordingly, an SIR of 150 is interpreted as 50% more cases than the expected number; an SIR of 90 indicates 10% fewer cases than expected.

Caution should be exercised, however, when interpreting an SIR. The interpretation of an SIR depends on both the size and stability of the SIR itself. Two SIRs can have the same size but not
have the same stability. An SIR of 150 based on six observed cases and four expected cases indicates a 50% excess in cancer, but this excess is actually only two cases. Conversely, an SIR of 150 based on 600 observed cases and 400 expected 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 unlikely that 200 excess cases of cancer would occur by chance alone.

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 and 1990 census data for Wayland (US DOC 1980, 1990). Midpoint 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.

C. Calculation of 95% Confidence Interval

In addition to calculating SIRs, the statistical significance of each SIR was also assessed. A 95% confidence interval (95% CI) was calculated 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). A 95% CI is a method of assessing the magnitude and stability of an SIR. 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 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 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 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 a result of chance and reflects
a real cancer increase or decrease. Again, as a result of the instability of incidence rates based on small numbers of cases, statistical significance was not assessed when fewer than five cases were observed.

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.

D. Determination of Geographic Distribution

In Wayland, the geographic distribution of cancer was determined using available address information from the MCR indicating residence at the time of diagnosis. This information was mapped for each individual using a computerized geographic information system (GIS) (MapInfo 1996). This allowed the assignment of census tract location for each case as well as an evaluation of the spatial distribution of cases at a smaller geographic level (i.e., neighborhoods). The geographic distribution was assessed using a qualitative evaluation of the point pattern of cases within the town 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 town residential lists issued within two years of an individual's diagnosis. Address locations were also confirmed by site visits to the area.

E. Evaluation of Cancer Risk Factors

The MCR routinely collects data related to possible risk factors for individual cancer cases (e.g., smoking status, and occupation). Smoking status information was reviewed for cancers with known or suggested associations with tobacco smoke and occupational information was reviewed for cancer types that have been associated with exposures in specific occupations. In addition,
available breast cancer case information for the years 1987-1994 was reviewed to evaluate the stage of the cancer at time of diagnosis.

However, information about personal risk factors (e.g., family history, hormonal events, diet) that may also influence the development of cancer is not collected by the MCR and, therefore, could not be evaluated in this investigation. In addition, many cancers have a lengthy latency period. The latency period is the interval between first exposure to a disease-causing agent(s) and the appearance of symptoms of the disease (Last 1995).

Cancer does not usually develop within months after exposure. For most cancers, the latency period is an interval usually between 12 to 25 years and in some cases may be more than 40 or 50 years (Bang 1996, Frumkin 1995).

IV. RESULTS OF CANCER INCIDENCE ANALYSIS

The following sections present cancer incidence rates for Wayland as a whole and for each census tract evaluated. Analysis by census tract or smaller geographic area helps in understanding whether the incidence of cancers observed town-wide may be explained by an increase or decrease in cases in a particular geographic area of the town. Section A presents results of cancer incidence analysis in Wayland for the years 1982-1992. Section B presents results of cancer incidence analysis in Wayland for the years 1987-1994 and 1995.

A. Results of Cancer Incidence Analysis in Wayland 1982-1992

Tables 1A through 3B summarize the cancer incidence data town-wide and for each census tract for three different time periods: 1982-1992, 1982-1986 and 1987-1992.

1. Cancer Incidence for Wayland as a Whole (Tables 1A & 1B)

During the 11-year period 1982-1992, cancer incidence in the town of Wayland occurred generally less often than expected. An elevation in pancreatic cancer was observed among males (10 cases observed versus 6.1 cases expected). This elevation was not statistically significant. Lung cancer occurred significantly less often than expected among males. Thirty-seven cases
occurred during the 11 years 1982-1992 where 53 cases were expected (SIR=70; 95% CI=49-97). Females experienced slight elevations in cancers of the lung and breast as well as leukemia and NHL. Elevations observed in these cancer types were based on a small number of excess cases (i.e., about three or less) and were not statistically significant.

When examined by smaller time period, cancer incidence in Wayland also generally occurred less often or equal to expected rates. Pancreatic cancer was elevated among males during the earlier time period 1982-1986. Among males, six cases occurred versus

approximately three expected cases (SIR=214). This elevation was not statistically significant. During the later time period, the incidence of pancreatic cancer in males was about as expected. Among females, pancreatic cancer occurred less often than expected in both time periods. Among females, breast cancer was elevated during the earlier time period but occurred less often than expected during the later time period 1987-1992. One case of breast cancer occurred among males in Wayland during the later time period 1987-1992. Lung cancer and NHL were slightly elevated among females during the later time period. Neither of these elevations was statistically significant.

2. Cancer Incidence in Census Tract 3661 (Tables 2A & 2B)

During the period 1982-1992, cancer incidence in CT 3661 occurred at lower than expected rates among males, females and among males and females combined for most of the cancer types evaluated. Slight and non-significant elevations were observed in kidney cancer among males and in NHL among females (two excess cases in each cancer). An elevation in lung cancer among females nearly achieved statistical significance (20 cases observed versus 12.5 cases expected).

The incidence of bladder cancer and leukemia occurred approximately equal to or less than expected for all three time periods examined and for both sexes. In addition, liver cancer occurred approximately equal to expected rates. No cases of liver cancer occurred among females during the 11-year period 1982-1992. Stomach cancer occurred less often than expected during all three time periods examined and among both sexes.

Breast cancer was elevated during the earlier time period in this census tract. Twenty-one cases occurred while slightly more than 16 cases were expected (SIR=130; 95% CI=80-198). Breast cancer occurred less often than expected during the later time period 1987-1992 (17 cases observed versus 23 cases expected). One case of male breast cancer was observed in CT 3661.

Hodgkin's disease occurred equal to or less than expected during the entire 11-year period 1982-1992 and during the later time period 1987-1992. During the earlier time period, Hodgkin's disease was slightly elevated. The elevation was based on one excess case.

The incidence of kidney cancer occurred generally less than or equal to expected overall and among females during all three time periods evaluated. Among males, the incidence of kidney cancer was elevated during 1982-1992 mainly due to an elevation during the later time period 1987-1992. The elevation was based on an increase of two cases and was not statistically significant. Five cases were observed during 1982-1992 and three cases were expected (SIR=164).

The incidence of lung cancer was greater than expected among females during 1982-1992. Lung cancer was also elevated among females during both the smaller time periods 1982-1986 and 1987-1992. These elevations however were not statistically significant. Among males the incidence of lung cancer was less than expected during the earlier time period 1982-1986 and occurred more often than expected during the later time period 1987-1992.

NHL was slightly elevated among females but occurred less often than expected among males during 1982-1992. The elevations experienced among females were not statistically significant.

The incidence of pancreatic cancer occurred about as expected overall for the entire time period 1982-1992. During the earlier time period 1982-1986, a slight elevation was observed among males (3 cases observed versus 1.2 cases expected). During the later time period, pancreatic cancer occurred less often than expected among both males and females.

3. Cancer Incidence in Census Tract 3662 (Tables 3A & 3B)

Overall, during 1982-1992, most cancer types occurred less often than expected in CT 3662. Lung cancer occurred significantly less often overall and among males. A total of 20 cases

occurred among males where slightly more than 33 were expected (SIR=60; 95% CI=37-93). The incidence of leukemia and pancreatic cancer was increased but not significantly. The incidences of breast cancer and leukemia were mainly due to an increase observed among females. The increases were due to an excess of one or two cases and were not statistically significant. NHL was elevated among females. This elevation was not statistically significant. The elevation observed in NHL was based on increase of one case and was not statistically significant.

Bladder cancer was less than or equal to expected during all three time periods evaluated. An increase of one case occurred among males during the later time period 1987-1992. Both lung cancer and stomach cancer occurred less often than expected in each time period evaluated and for each of the sexes. Lung cancer occurred significantly less often among males and females combined during the later time period 1987-1992.

Breast cancer occurred less often than expected during the earlier time period but was elevated during the later time period 1987-1992. The elevation was not statistically significant.

No cases of Hodgkin's disease or liver cancer occurred in this census tract during the earlier time period 1982-1986. The incidence of Hodgkin's disease was less than expected during the later time period 1987-1992. One case of liver cancer occurred among males and one among females during 1987-1992.

With the exception of females during the later time period 1987-1992, the incidence of kidney cancer and NHL occurred less than or equal to expected rates during all three time periods evaluated. During the period 1987-1992, five cases of NHL occurred among females where approximately three cases were expected (SIR=277). This elevation was not statistically significant.

The incidence of leukemia occurred less often than expected among males during all three time periods examined. Females experienced a small increase in leukemia during 1987-

1992. Three cases occurred in this CT 3662 where slightly more than one case would have been expected. These three cases were of different histologic types of leukemia and occurred in individuals over the age of 55. This pattern is consistent with the epidemiology of leukemia, and does not suggest an unusual pattern.

Pancreatic cancer occurred less often than expected among females during all three time periods. However, the incidence of this cancer was slightly elevated among males in each of the time periods evaluated. During the period 1982-1986, three cases occurred where approximately two cases were expected. During the later time period 1987-1992, four cases occurred where approximately two cases were expected. None of the observed increases were statistically significant.

B. Results of Cancer Incidence Analysis in Wayland 1987-1994 and 1995

Tables 4 through 6 summarize the cancer incidence data town-wide and for each census tract for the time period 1987-1994.

1. Cancer Incidence in Wayland as a Whole (Table 4)

During the entire time period 1987-1994, cancer incidence in the town of Wayland generally occurred at or near the expected rates. In fact, most cancer types evaluated occurred at approximately the same rates observed during the 1987-1992 time period.

During the previous investigation (1987-1992), pancreatic cancer among males occurred about as often as expected (four cases observed versus approximately three expected). During 1987-1994, male pancreatic cancer also occurred about as often expected (five cases observed versus approximately five expected).

Although female breast cancer occurred less often than expected during 1987-1992, the incidence of female breast cancer occurred more often than expected during 1987-1994.

Eighty-one cases occurred during the eight year period when approximately 75 were expected (SIR=108). This elevation was not statistically significant.

Lung cancer incidence during the 1987-1994 time period was consistent with what was observed during the 1987-1992 time period. During 1987-1994, lung cancer among males occurred less often than expected (32 cases observed versus approximately 43 expected). Among females, lung cancer was slightly elevated; thirty-one cases were observed where approximately 27 were expected. Among males and females combined, lung cancer occurred less often than expected; 63 cases occurred when approximately 70 cases were expected (SIR=90). This observation was largely due to the pattern observed among males.

Among females, NHL occurred slightly more often than expected (11 cases were observed where approximately seven were expected). This elevation is due to an excess of approximately four cases and is similar to the pattern observed among females for the 1987-1992 period. During 1987-1994, the incidence of all other cancer types occurred less than or about as expected, based on the statewide experience.

It should be noted that upon re-evaluation of the incidence of Hodgkin's Disease for the years 1987-1992, a previous data entry error was discovered. During the time period 1987-1992, the state observed number of cases used to calculate the SIR resulted in an overestimate of expected numbers of cases in Wayland (i.e., 6.2 expected cases vs. 2.6 expected cases). This error was corrected for the 1987-1994 analysis and did not significantly change results. Overall, during 1987-1994, Hodgkin's Disease generally occurred about as often as expected.

In 1995, a total of 25 new cases of cancer (different types) occurred in Wayland. One additional case was reported for cancers of the bladder, kidney and pancreas; all occurred among males. In addition, two cases of NHL, three cases of stomach cancer, and thirteen cases of female breast cancer were observed. Four new cases of lung cancer were diagnosed in 1995, two of these cases

occurred among males, and two occurred among females. No cases of leukemia, liver cancer or Hodgkin's Disease occurred among Wayland residents in 1995.

2. Cancer Incidence in Census Tract 3661 (Table 5)

A similar pattern of cancer incidence was observed for the years 1987-1994 in CT 3661 as was observed during the 1987-1994 time period. During the eight-year time period, elevations were observed in two of the ten cancer types evaluated; lung cancer and NHL. NHL occurred more often than expected among males in CT 3661. Five cases were observed when approximately three were expected. In addition, lung cancer was statistically significantly elevated among females. Nineteen cases were observed when 11 were expected. (SIR=172; 95% CI=104-269). The remaining eight cancer types evaluated occurred less than or approximately equal to the expected rates.

In 1995, eight new cases of cancer (different types) were diagnosed among residents in this census tract. One case was observed for cancers of the bladder, lung and NHL. Three cases of female breast cancer occurred and two cases of stomach cancer were also reported. No cases of cancers of the kidney, liver, pancreas, leukemia or Hodgkin's Disease occurred in 1995 in CT 3661.

3. Cancer Incidence in Census Tract 3662 (Table 6)

During the time period 1987-1994, most cancer types in CT 3662 occurred at or near the expected rates. Breast cancer occurred more often than expected among females. Fifty-six cases were observed where approximately 44 were expected. This is similar to the pattern observed during 1987-1992. This elevation was not statistically significant. NHL occurred slightly more often than expected among females in this census tract. This elevation was based on an excess of two cases. A total of six cases were observed and four were expected (SIR=148).

Lung cancer occurred statistically significantly less often than expected among males, and among males and females combined. Overall, 29 cases were observed when approximately

44 were expected (SIR=66). No new cases of male pancreatic cancer were diagnosed during the 1987-1994

time period, and all other cancer types evaluated occurred about as often as expected (i.e., no more than one or two excess cases) or less than expected.

Evaluation of the most recent cancer incidence data for the year 1995 indicates that 17 additional cases of cancer (different types) were reported among residents of CT 3662. One case was observed for cancers of the kidney, pancreas, stomach and NHL. Ten cases of female breast cancer occurred and three cases of lung cancer were also reported. No cases of bladder cancer, liver cancer, leukemia or Hodgkin's Disease occurred.

C. Evaluation of Geographic Distribution

Place of residence at the time of diagnosis was mapped for all cancer types to assess any possible geographic pattern of cases. In addition to determining census-tract-specific incidence ratios for each cancer type, a qualitative evaluation was conducted to determine whether any specific cancer type appeared to be concentrated in some area(s) or within any of the census tracts in Wayland.

Review of these data showed that there were no apparent spatial patterns of any specific cancer type at smaller geographic levels (i.e., neighborhoods) within the two census tracts in Wayland that was not likely attributed to the presence of a multi-unit complex, a nursing home, or more densely populated areas within the census tracts.

In addition, concerns have been raised regarding suspected increases in cancer incidence specifically in the neighborhoods of the Dow Chemical site located on Commonwealth Road in CT 3661. Review of the geographic distribution of cancer cases in this area did not reveal any unusual geographic pattern or clustering of any one cancer type. The cancer types that occurred in this area were different primary site cancers and no pattern was observed with respect to age, gender or year of diagnosis.

The former Dow Chemical site is located less than one-half mile north of the border between the towns of Wayland and Natick. Concerns have been expressed that contamination at the Dow

Chemical site may be related to the incidence of cancer in the surrounding area including the northwest portion of the town of Natick. The MDPH completed an evaluation of cancer incidence in Natick, MA (MDPH 1997b). The geographic distribution of cancer cases in the bordering census tract in Natick (CT 3821) was reviewed in relation to the Dow Chemical site. Again, review of this information did not reveal any concentrations or unusual pattern of any one cancer type in the Natick CT 3821 that borders the town of Wayland (MDPH 1997b).

D. Evaluation of Cancer Risk Factors

As previously mentioned, cancer is a term that describes a variety of diseases. As such, epidemiological studies have generally shown that different cancer types have separate causes, patterns of incidence, risk factors, latency periods (i.e., period between exposure and development of disease), characteristics and trends in survival (Shottenfeld and Fraumeni 1996). Available information related to factors known to be responsible for the development of cancer (e.g., smoking and occupation) were reviewed for the relevant cancer types described in this report.

1. Smoking Status

a. 1982-1992

Smoking is the most important known risk factor for cancers of the bladder, kidney, lung and pancreas. The smoking status of individuals in Wayland diagnosed with these cancers during the years 1982-1992 was reviewed. As shown in Figure 2A, with the exception of

kidney cancer, the majority of individuals diagnosed with these cancer types in Wayland were reported as current or former smokers.

Figures 3A and 3B present the distribution of cases with a known smoking status for each of the four cancer types evaluated in Wayland and the state. With the exception of kidney cancer, there were a greater number of current or former smokers in Wayland than individuals who reported never smoking. For lung cancer, among those who reported a smoking status, the majority of individuals (97%) were current or former smokers. Comparison of smoking status for kidney and
bladder cancer in Wayland and the state showed that the percent of current or former smokers was less in Wayland than in the state. The distribution of smoking status for pancreatic cancer among individuals in Wayland and the state was nearly equivalent.

b. 1987-1994

During the eight year period 1987-1994, the incidence of lung cancer was statistically significantly elevated among females in CT 3661 (19 cases were observed when 11 cases were expected; SIR=172). Smoking is the principal risk factor for the development of lung cancer. Therefore, the distribution of smoking status among female lung cancer cases in this census tract was reviewed and compared to the smoking status of female lung cancer cases in both Wayland as a whole and the state of Massachusetts. Review of smoking status information for female lung cancer cases in CT 3661 showed that the majority of cases (68%) were current or former smokers (refer to Figure 4). In addition, the distribution of current or former smokers among female lung cancer cases in Wayland was similar to that for female lung cancer cases in Massachusetts where 77% and 80% were current or former smokers.

2. Occupation

Occupational information as reported to the MCR was reviewed for cancer types that have been associated with exposures in specific occupations. This information was reviewed to

determine whether occupational factors might have contributed to the development of some cancers in Wayland. Occupation as reported to the MCR at the time of diagnosis was reviewed for cancer cases of the bladder, lung, pancreas, kidney, leukemia and NHL.

In general, review of this information did not reveal occupations that are known or suspected to be associated with the cancer types evaluated. Some individuals did report occupations that may have been associated with exposures suspected in the development of their disease. However, some cases reported to the MCR do not contain meaningful occupational information (e.g., occupation may be listed as "retired"). In other cases, no information is provided. The occupational data reported to the MCR for the majority of individuals is limited to job title or company name and
does not include specific job-duty information that could further define exposure potential. Therefore, the available information is generally not sufficient to determine whether occupational exposures may have occurred in some cases or what role occupation may have had in cancer incidence in the town of Wayland.

E. Evaluation of Breast Cancer Stage at Diagnosis, 1987-1994

The stage of cancer as reported to the MCR at the time of diagnosis was reviewed for breast cancer cases diagnosed between the years 1987-1994 in Wayland and each of it's two census tracts. Staging categorizes the extent of disease and its spread at the time of diagnosis. An evaluation of staging information can help determine whether cancer patients in a given area are being diagnosed at an early or late stage of the disease. This information can be used to determine the level of breast cancer screening taking place in a community. A high level of screening can lead to an increase in breast cancer incidence through better detection of early stage breast cancer. It is also important to examine the distribution of staging because breast cancer survival correlates strongly with a diagnosis of early stage cancer, especially with cancer limited to the breast (local or stage I) (ACS 1999).

This analysis defines stage in four categories: localized, regional, distant, or unknown. Localized breast cancer represents a diagnosis that the tumor is invasive but the cancer is

confined to the breast. Regional indicates that the tumor has spread beyond the organ of origin (breast). This may include spread to adjacent tissues or organs, lymph nodes or both. Distant indicates that the cancer has metastasized or spread to organs other than those adjacent to the organ of origin, or to distant lymph nodes or both (MCR 1996). Some of the cases reported to the MCR are reported with an unknown stage. This indicates that at the time of reporting the tumor had not been staged.

The distribution of the stage at diagnosis for female breast cancer cases in Wayland during 1987-1994 was similar to the distribution observed in Massachusetts as a whole (see Figure 6). In both Wayland and Massachusetts, a greater percentage of breast cancer cases were diagnosed at an early (i.e., local) stage than later stages of disease (i.e., regional and distant). As shown in Figure 6, 74% of the female breast cancer cases in Wayland were diagnosed at an early or local stage, while 21%
of cases were detected at later stages (20% regional and 1% distant). The stage of diagnosis was unknown for 5% of the breast cancer cases in Wayland.

Although in both Wayland and Massachusetts the majority of the female breast cancer diagnoses were at the local stage (74% in Wayland versus 62% in Massachusetts), Wayland showed 12% more local breast cancer diagnoses than the state during 1987-1994. In contrast, a greater percentage of breast cancer cases were diagnosed in Massachusetts at the regional and distant stages.

When stage at diagnosis was reviewed by census tract in Wayland, the majority (i.e., greater than 65%) of female breast cancer diagnoses in both census tracts was at the local stage (see Figure 7). However, although the majority of the female breast cancer diagnoses in both census tracts were at the local stage (68% in CT 3661 versus 77% in CT 3662), CT 3662 showed 9% more local breast cancer diagnoses than CT 3661 during 1987-1994. This increase in local diagnoses may be the result of greater use of screening services within this area of the town, and may help to explain the elevation in breast cancer incidence in this census tract and in the town of Wayland.

V. COMMUNITY ENVIRONMENTAL CONCERNS

A. Hazardous Waste Sites

Information regarding hazardous waste sites located in the town of Wayland and listed by the Massachusetts Department of Environmental Protection (MDEP) was obtained and reviewed. The MDEP is the state agency responsible for the monitoring, assessment and clean up of releases of oil and hazardous materials at disposal sites in Massachusetts. These sites are regulated under Massachusetts General Laws, Chapter 21E.

A total of 17 sites located in Wayland were identified by the MDEP as Confirmed disposal sites or Locations to be Investigated (LTBI) during the years 1987-1993 (MDEP 1995a). Of these sites, four (including the Dow Chemical site) are listed as Confirmed, nine are listed as LTBI and four sites have Waiver status. (Confirmed status is a location confirmed by the MDEP to be a disposal site, and for which remedial response actions have not been completed. Waiver status are locations confirmed by the MDEP to be non-priority disposal sites, and where an interested party has been authorized to proceed with response actions without MDEP oversight. LTBIs are locations the MDEP considers reasonably likely to be disposal sites but are as yet unconfirmed.) There was no unusual pattern or concentration of cancer types in Wayland in relation to Confirmed disposal sites or LTBI listed by the MDEP. Refer to Figure 7 for the location of MDEP 21E sites.

B. Former Dow Chemical Company Site

Numerous environmental investigations have taken place at the Dow site. The following section is a review of environmental information and data for the Dow site based on a the following reports:

- *Final Preliminary Assessment Report, Dow Chemical Corporation (former), Wayland, MA,* prepared by the CDM Federal Programs Corporation for the U.S. Environmental Protection Agency (CDM 1995).

- *Phase II Comprehensive Site Assessment, Former Dow Chemical Facility, Wayland, MA,* prepared by Ransom Environmental Consultants in March 1999 (Ransom 1999a).
- *Phase II Comprehensive Site Assessment, Addendum and Errata Sheet, Former Dow Chemical Facility, Wayland, MA,* prepared by Ransom Environmental Consultants in September 1999 and in January 2000 (Ransom 2000a).
- *Method 3 Risk Characterization, Former Dow Chemical Facility, Wayland, MA,* prepared by Gradient Corporation in January 2000 (Gradient 2000).
- *Completion Report, Release Abatement Measure No. 3, Former Dow Chemical Facility, Wayland, MA,* prepared by Ransom Environmental Consultants in March 2000 (Ransom 2000b).
- *Results of Sampling Activities, Voluntary Response Action, Former Dow Chemical Facility, Wayland, MA,* prepared by Ransom Environmental Consultants in March 2000 (Ransom 2000c).
- *Facility Closure Report, Former Dow Chemical Facility, Wayland, MA,* prepared by Ransom Environmental Consultants in April 2000 (Ransom 2000d).

1. Site Description

The former Dow Chemical Company site covers approximately 16 acres and consisted of a former small scale research facility located in the western portion of a 35.71 acre property located at 412 Commonwealth Road (Route 30) in Wayland, MA (Ransom 2000a). Dow operated a chemical research facility known as the Wayland Eastern Research Laboratory at the site between 1964 and 1988. Operations at the facility consisted of chemical research activities (e.g., synthesis of agricultural and pharmaceutical compounds) (CDM 1995, Greene 1997). Currently, the site is unoccupied and consists of vacant land (Gradient 2000).

The eastern portion of the property is undeveloped. The site is abutted to the south by undeveloped wetlands and wooded areas on the Willow Brook Farm condominium complex property, and to the west by undeveloped land and protected open space on Rice Road (Gradient 2000). Walking trails wind through the wooded portion of the property.

The western portion of the site was developed for commercial use. Several buildings were formerly located at the site including a main office, a laboratory building, a cooling tower building, a solvent

storage shed, a garage, and a small shed. All buildings were demolished between January and March 2000 (Ransom 2000b). No buildings are currently at the site. Refer to Figure 5 for locations of the former buildings.

Three ponds, referred to as the North, West, and East Ponds, are also located on the site. The North Pond is located northeast of the former laboratory building and drains south to the two smaller ponds. East Pond and West Pond are located in the southernmost and lowest portion of the site along Commonwealth Road. Two underground storage tanks (USTs) for heating oil were also present on the property. These USTs were removed in November 1996 (Ransom 1997a). In addition, two septic systems formerly existed on the property; one served the main floor of the laboratory building and the second served the basement floor of the laboratory building.

Based on employee reports and environmental investigations, several areas of possible contamination were identified on the site. These areas include the former shallow disposal area, the former burn bucket area and concrete pad area, the upper septic system area, and the former UST and lower septic system area (Refer to Figure 5). During the 1970s and 1980s, Dow dredged the North Pond and West Pond for aesthetic reasons and to prevent the ponds from drying up during the summer months (Ransom 1999a). These piles of dredged pond sediments were located near the former burn bucket area and the former concrete pad. In the past, the site was not fenced and local residents frequently walked on the property in both developed and undeveloped areas (CDM 1995).

Groundwater under the site flows in a south-southeasterly direction and can be found on average at 11 feet below the ground surface (Gradient 2000). Land use surrounding the site is residential. The nearest residence is located approximately 500 feet west of the property on Rice Road. An estimated 4,321 residents live within a one-mile radius of the property. Three municipal wells in the bordering town of Natick are located over one mile south of the site (Ransom 1999a). There are no public or private water supply wells located within a one mile radius of the site (Gradient 2000).

2. Site History

Dow purchased the property in 1963 and owned it until 1988. Before its use as a chemical facility, the property was part of a farm. In 1989, New England Development (NED) purchased the property from Dow with intentions of building office buildings on the site. However, after the discovery of environmental contamination, the property was resold to Dow in February 1995.

As previously mentioned, Dow's operations at the site primarily consisted of research. The types of wastes handled by Dow included chlorinated solvents, acids, metals, alcohols, other organic compounds, and possibly herbicides. According to the *Phase II Comprehensive Site Assessment*, Dow disposed of solvents and wastes in several areas of the site (Ransom 1999a). Incineration of flammable solvents and fire training occurred in the former burn bucket area located in the northeastern area of the site. Dow also disposed of empty and broken solvent bottles (stored primarily in tubes and ampules) in the former shallow disposal area located south of and adjacent to
the former garage. This activity reportedly took place between 1964 and 1970. Within this area, small quantities of sodium, lithium, and other compounds such as copper sulfate were buried and covered with dirt (Ransom 1999a). A sump located near the former laboratory building collected cooling water, which was used to clean laboratory instruments. This sump drained into North Pond. Reportedly, solvents used to clean laboratory glassware were routinely washed down the drains into the upper septic system at the site (Ransom 1999a).

In February 1994, the Dow site was designated by the MDEP as a Tier 1A site under the state Superfund program. The site received this designation due to concern over the potential existence of chemicals on the site which are not detected by standard analyses and due to the lack of information on past chemical usage at the site (MDEP 1998b). This designation required the MDEP to oversee all cleanup or response actions at the site. In February 1999, the MDEP reclassified the Dow site as a Tier 1C site (MDEP 1999a). Under this designation, the MDEP no longer provided direct oversight of investigations or other activities that occurred at the site. Site investigations were completed in June 2000 (Ransom 2000). The town of Wayland plans to purchase the Dow property for use as conservation land. According to the *Method 3 Risk Characterization*, a deed restriction will be placed on the property as a condition of the sale in order to prevent use of the property for residential housing (Gradient 2000, Ransom 1999d).

3. Site Remedial Activities

Numerous environmental investigations and remedial activities have occurred at the Dow site. In October 1994, Dow began implementing a Release Abatement Measure (RAM) plan for the site. The RAM activities included sampling areas of suspected contamination on the site and the removal of contaminated soil and debris. RAM activities also included the removal of two underground storage tanks (USTs), the installation of soil borings and monitoring wells and the analysis of soil and groundwater samples (MDEP 1998a).

Specifically, the major activities that occurred as part of the RAM included the following:

- Seventeen soil samples were collected from the area of the upper septic system and analyzed for the presence of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, inorganic compounds, pesticides, and herbicides. Soil samples were collected at depths ranging from four to eight feet. In addition to sampling in the upper septic system area, soil samples from depths of two to four feet were collected for analysis from what is referred to as the stone disposal area west of the upper leaching field. Two-to-four foot samples were also collected in a subset of the boring locations associated with the upper septic system.

- Test pit excavation and soil sampling in the former burn bucket area. Four shallow test pits were excavated in two burn areas (referred to as Burn Bucket Area 1 and 2). The pits were excavated to a depth of three feet or greater if possible. Four composite soil samples from each area were collected and analyzed for VOCs, SVOCs, and metals.

- Removal of the concrete pad in the former fire training area, soil removal, and residual soil sampling. Soil was excavated to a depth of two feet in the area of and surrounding the removed

concrete pad (a slab four inches thick). Six soil samples were collected in an area in and around the pad and analyzed for VOCs, SVOCs, and metals.

- Test pit excavations and soil sampling in the former shallow disposal area. Four soil samples were collected for chemical analysis from two test pit areas and analyzed for VOCs, SVOCs, metals, and inorganic compounds. Test pits were excavated to a depth of four feet east of the former cooling tower building. Soil and debris consisting of broken and intact vials, small bottles, and other laboratory glassware were unearthed (Ransom 1999a). Vials and other glassware as well as excavated soil were placed in drums for disposal.

A second RAM plan for the site was implemented in November 1996. At that time, two USTs were removed and additional soil sampling in the former shallow disposal area and former burn bucket area was conducted (Ransom 1997a). None of the samples collected detected contaminants at concentrations that were greater than the previous sampling rounds (Greene 1997a).

As part of the remedial activities at the site, the Dow Chemical Company retained Gradient Corporation to develop soil clean-up guidelines for compounds that were identified in on-site soil during the second RAM. These compounds include organotin and organomercury compounds -- compounds that were present at the Dow site (based on company records) and for which no clean-up guidelines exist (Greene 1997b). Gradient Corporation developed soil clean-up guidelines for these compounds, which were approved for use by the MDEP (Gradient 1995 and 1996; MDEP 1996, Ransom 1999a).

Ransom Environmental Consultants, Inc. conducted a *Phase II Comprehensive Site Assessment* for the former Dow Chemical facility in the fall of 1998. As part of the *Phase II Comprehensive Site Assessment*, surface water and sediment samples were collected from the North Pond, East Pond, and West Pond. In addition, sediment samples were collected from the dredged sediment piles (containing sediments from the North Pond and the West Pond), and seven new groundwater monitoring wells were installed and sampled at the site.

4. Summary of Environmental Sampling

It should be noted that this report is not a comprehensive review of all environmental investigations that have taken place at the Dow site. Over the past thirteen years, various environmental samples have been collected and analyzed at the Dow site. These samples have been taken to monitor septic systems, to evaluate residual contamination associated with the USTs, and to determine the nature and extent of contamination associated with historical waste disposal practices at the facility. The MDPH has reviewed and analyzed all available environmental sampling data for the Dow site. Due to the large volume of environmental sampling data that exists for the former Dow site, the following discussion is a limited summary of the sampling that has occurred at the site. The focus of this review is to identify potential chemicals of concern detected in environmental media at the site to which people may have been or could be exposed. A complete presentation of the results of environmental sampling at the site is provided in the *Phase II Comprehensive Site Assessment* (Ransom 1999a).

To provide a screening-level evaluation of the possible health significance of chemicals detected on the Dow site, the maximum detected concentration of a chemical detected in any location on the site was compared to the Agency for Toxic Substances and Disease Registry (ATSDR) comparison values (ATSDR 2000). The ATSDR comparison values are media- and chemical-specific concentrations that are used by health assessors to select environmental contaminants for further evaluation. Comparison values are screening-level guidelines, that is, media concentrations less than a comparison value are unlikely to pose a health threat. However, because comparison values were developed as media-specific guidelines, the health risks resulting from concurrent exposures to chemicals in more than one medium need to be considered. Also, media concentrations above a comparison value do not necessarily represent a health threat; for a health threat to be present, an individual must actually be exposed or come into contact with the chemical.

a. Surface Soil

As part of an *Environmental Assessment* conducted at the Dow site in 1988 by Anderson-Nichols & Company, Inc. (as discussed in the *Final Preliminary Assessment*), four surface soil samples were

collected from the former shallow disposal area and the former burn bucket area located on the eastern portion of the property. The ATSDR, however, defines surface soil as 0 to 3 inches below the ground surface and no samples of this depth were collected at the Dow site. The four surface soil samples collected in 1988 were taken at a depth of 0 to 2 feet. The samples were analyzed for VOCs and SVOCs.

In three of the four samples, one SVOC (bis(2-ethylhexyl)phthalate) was detected at a maximum concentration of 1.6 mg/kg (i.e., parts per million [ppm]). This concentration was detected in the former shallow disposal area and is well below the ATSDR comparison value of 50 mg/kg (a cancer risk evaluation guide). It should be noted that the presence of bis(2-ethylhexyl)phthalate in low concentrations in environmental samples is often attributed to laboratory contamination. Several polycyclic aromatic hydrocarbons (PAHs) were also detected in one of the four samples collected in the burn bucket area. These PAHs were detected at concentrations ranging from 0.49 mg/kg phenanthrene to 1.2 mg/kg pyrene. The detected concentrations are above reported PAH background levels for rural areas but well within the range of expected concentrations for urban areas (ATSDR 1995). In addition, PAHs are products of combustion and would be expected to be found at concentrations above background in an area where burning took place.

Since the Anderson-Nichols & Company, Inc. *Environmental Assessment* was conducted in 1988, soil in the burn pit area has been excavated as part of the 1996 RAM activities. Therefore, the concentrations of PAHs detected in 1988 most likely do not reflect current soil conditions at the site.

Other RAM activities included additional soil sampling conducted in the upper leachfield, in a stone disposal area located west of the upper leachfield, the former burn bucket area, and the former shallow disposal area. The soil was analyzed for VOCs, SVOCs, and total metals. Some of the soil samples analyzed as part of the RAM were collected at depths of two feet or less. Shallow samples (0-2 feet) were collected west of the upper leachfield (B109-S1 and B110-S1), in the concrete pad area (EB1-S1, EB2-S1, CPOE-S1, and CPOE-S2), and in the burn bucket area (BBA1-S1 and BBA2-S1). Some chemicals detected at the above sampling locations were not on the USEPA Target Compound List (TCL) for Superfund sites (CDM 1995). The TCL contains 129 compounds that are considered as potentially hazardous and analyzed at Superfund sites. During any site investigation it is not unusual

that some non-TCL compounds are detected but not identified or tentatively identified during laboratory analysis. The unidentified compounds found at the Dow site were detected at very low concentrations (i.e., less than 0.05 mg/kg). Further investigations revealed that some of these compounds had origins as plant derived organic matter, and were therefore thought to be products of decomposition.

Of those compounds that were identified, PAHs were the most commonly detected. The maximum detected concentrations of PAHs in the 0 to 2 feet depth samples were found at CPOE-S2 in the concrete pad area and ranged from 1.1 ppm 2-phenylnaphthalene to 9.8 ppm fluoranthene. Chyrsene and benzo(a)pyrene were above rural/urban background concentrations and

benzo(a)pyrene exceeded the comparison value (0.1 mg/kg). In one sample (CPOE-S2), xylenes were detected at a concentration well below the ATSDR comparison values for this chemical. For those metals for which comparison values or background data exist, the metals detected in the surface soil were either below or approximately equal to comparison values or within the range of reported background levels.

Additional soil sampling in the former shallow disposal area and the former burn bucket area was conducted as part of the second RAM. Again, no contaminants were detected at concentrations greater than what was discovered during the initial RAM (Greene 1997a).

b. Subsurface Soil

As part of the *Environmental Assessment* conducted in 1988, subsurface soil samples were collected in the upper and lower leachfields. For purposes of this report, subsurface soil samples are considered as those collected at a depth greater than two feet. The samples were analyzed for VOCs and SVOCs. The only compound detected in the three samples was bis(2-ethylhexyl)phthalate ranging from 0.43 to 0.73 mg/kg. These concentrations are well below the soil comparison value for this chemical.

As part of the *Addendum to Phase I Investigation* prepared in May 1993 by Environmental Science Services (ESS) (and summarized in the *Final Preliminary Assessment Report*), subsurface soil

samples ranging in depth from 5 to 12 feet were collected from the upper and lower leachfield. These samples were analyzed for the presence of VOCs, SVOCs, metals, and dioxins. The compounds detected included PAHs, metals, and bis(2-ethylhexyl)phthalate. Please refer to table 6 of the *Final Preliminary Assessment Report* for a complete presentation of the analytical data. Of the metals detected in the subsurface soil, the maximum detected concentrations were either below or approximately equal to the soil comparison values. PAHs were detected in one sample at a five-foot depth. The detected concentrations of PAHs were typical of urban soil (in the low parts-per-million range) but above background rural concentrations. For those PAHs with soil comparison values, only one compound (benzo(a)pyrene) was detected at a concentration (1.85 mg/kg) above

its comparison value (0.1 mg/kg) but similar to reported background concentrations. The detected concentration of bis(2-ethylhexyl)phthalate was well below its soil comparison value.

As part of the 1994 RAM activities, additional subsurface soil sampling occurred in the upper leachfield (B101-S3 and -S4, B103-S3 and -S4, B104-S4, B105-S3, and B107-S3), and the former shallow disposal area (TP01-S1 and TP01-S2, TP02-S1 and TP02-S2). The soil was analyzed for VOCs, SVOCs, and total metals. The complete analytical results are presented in Tables 8 and 9 of the *Final Preliminary Assessment Report* and in the *Phase II Comprehensive Site Assessment* (CDM 1995, Ransom 1997).

Of the detected metals for which an ATSDR comparison value exists, the highest detected concentrations of arsenic and antimony were above their respective comparison values and reported background levels. The highest detected concentration of arsenic in subsurface soil (at a two to four feet depth in the shallow disposal area) was 48 mg/kg, compared to its comparison value of 0.5 mg/kg and reported background levels of 1 to 40 mg/kg (ATSDR 1993). The highest detected concentration of antimony (28 mg/kg) is above its comparison value (20 mg/kg). Although no comparison value exists for mercury, mercury was detected in the shallow disposal area at 62 mg/kg, above background levels (MDEP 1998c). Other metals detected in the soil were either below or approximately equal to comparison values or below reported background levels.

Again, some of the chemicals detected at these sampling locations were not on the USEPA TCL for Superfund sites. The TCL includes the most commonly found and known toxic compounds detected at hazardous waste sites. It is not unusual when conducting site sampling to detect non-TCL compounds. The presence of non-TCL compounds does not necessarily indicate that these compounds are contaminants of concern. It should be noted that several of these unknown compounds were found to have origins of decaying plant matter (i.e., terpene and wax compounds). The remaining unknown compounds were partially identified and separated into classes of compounds (e.g., polycyclic aromatic hydrocarbons) (MDEP 1995b). Again, these compounds were detected at very low concentrations and at a depth greater than three inches below ground surface in a heavily wooded area of the site. Therefore, these compounds were not considered as

contaminants of concern. For those organic compounds that were identified and for which an ATSDR comparison value exists, none were detected at a concentration above a comparison value.

c. Groundwater

Monitoring wells have been installed and groundwater sampling has occurred numerous times at the Dow site over the course of the last thirteen years. A summary of the monitoring well installations and sampling programs is given below:

- As part of the *Preliminary Environmental Site Assessment*, GZA installed five monitoring wells in the leachfield area during November 1988: GZ-1, GZ-2, GZ-3, GZ-7, and GZ-9. Environmental sampling results indicated the presence of trace levels of an unidentified compound in GZ-1, GZ-2, and GZ-3 and a trace amount of toluene in GZ-7.

- As part of the *Addendum to Phase I Investigation*, ESS installed five monitoring wells in the leachfield area and northwest of the East Pond (Refer to Figure) in March 1993: PW-1, PW-2, PW-5, PW-6, and PW-7. Wells PW-1 and PW-7 were sampled in April 1993 and the following compounds were detected: acetone and toluene (in both PW-1 and PW-7), and 2-butanone (in well PW-7). The detected concentration toluene in both wells

exceeded drinking water comparison values. Potential exposures to these contaminants are fully discussed further in section VI.

- In December 1993, the MDEP examined the monitoring wells for free phase petroleum product and screened the wells for VOCs. No VOCs or free product were detected.

- In April 1994, ESS sampled monitoring wells GZ-1, GZ-2 and AN-2 (an older well). According to the *Final Preliminary Assessment Report*, bis(1,1-dimethylethyl)phenol was detected at 5 ppb and an unidentified compound was also detected. No drinking water comparison value exists for bis(1,1-dimethylethyl)phenol.

- As part of the *Phase II Comprehensive Site Assessment*, seven new monitoring wells were installed at the Dow site (MW-101 through MW-107). In addition, groundwater samples were also obtained from existing monitoring wells AN-2, AN-3, AN-4, GZ-1, GZ-2, and GZ-7. VOCs such as benzene, TCE and 1,1,1-TCA were detected in monitoring wells located downgradient from the shallow disposal area. The maximum concentration of each VOC detected was below MDEP groundwater standards (Ransom 1999a).

- Groundwater sampling was conducted as part of the Voluntary Response Actions in the spring of 2000. Samples were obtained from the eastern undeveloped portion of the property, the sump area, and a private property located on Thompson Road, west of the Dow site. Sampling results indicated that no oil and/or hazardous material was detected (Ransom 2000c).

Potential exposures to compounds detected in the groundwater are fully discussed in section VI.

d. Surface Water and Sediment

The ponds on the Dow site have been sampled at different times. In 1981, Dow collected samples from the North and West Ponds. It is not clear from the *Final Preliminary Assessment Report*

whether surface water or sediment samples were collected. The highest concentrations of arsenic, mercury and chlorinated solvents were detected in the North Pond. The maximum concentration of lead (9.0 mg/kg) was detected in the West Pond. In 1992, GZA collected two sediment samples from each of the three ponds on the site. Several PAHs and metals were detected in the sediment samples. Although ATSDR comparison values do not exist for sediment, soil comparison values were used as screening values. This is a conservative evaluation because the health risks from exposure to sediment would be expected to be less than soil due to a lower magnitude of exposure to sediment than soil. For those chemicals detected in the sediment for which soil comparison values exist, the detected concentrations of most chemicals were below or approximately equal to the comparison values. However, the detected concentrations of fluoranthene and pyrene in one of two samples collected from the West Pond exceeded their respective soil comparison values.

Flouranthene was detected at a maximum concentration of 3,200 mg/kg, exceeding the ATSDR comparison value of 2,000 mg/kg. Pyrene was detected at a maximum concentration of 3,400, also exceeding the comparison value of 2,000 mg/kg. Arsenic and mercury were detected in both samples at concentrations either below comparison values or within regional background concentrations. No VOCs, pesticides, PCBs, or dioxins were detected in the sediment samples.

In 1998 four sediment samples were obtained from the dredged piles of pond sediments. These samples were analyzed for metals, VOCs, SVOCs, pesticides, herbicides, dibenzodioxins, dibenzofurans, and inorganic compounds. Results of this analysis indicated the presence of metals, SVOCs, VOCs, as well as dioxin and furan compounds. For those compounds detected for which a comparison value was available, the maximum detected concentration of the majority of the compounds were either below ATSDR comparison values or MDEP cleanup standards.

e. Septic System

The contents of the septic tanks have been sampled and analyzed several times. The results of the analyses are contained in the *Final Preliminary Assessment Report* but are not reported here. The focus of this section is environmental media to which individuals have been or could be exposed; contact by individuals with the septic system contents is highly unlikely.

VI. DISCUSSION

A. Cancer Incidence Data

The available data do not suggest that residents of Wayland experienced excessive rates of cancer incidence during the entire time period 1982-1994. Between the years 1982-1994, cancer incidence generally occurred at or below the expected rates in both the town of Wayland as well as in census tracts 3661 and 3662.

In the previous analysis of cancer incidence data in Wayland, during the time period, 1982-1992, there were no statistically significant elevations observed in any of the cancer types evaluated
(MDPH 1997). Furthermore, lung cancer occurred significantly less often among males in the town of Wayland as well as in CT 3662. Although slight elevations in pancreatic cancer among males as well as breast cancer and NHL among females were observed, the elevations were based on small numbers of cases (i.e., less than four cases) and none of these cancer types were consistently elevated across time periods or among both sexes.

During the later time period, 1987-1994, breast cancer occurred more often than expected among females in the town of Wayland as well as in CT 3662. However, this elevation was not statistically significant. Review of staging information at time of diagnosis for breast cancer cases in both the town of Wayland and CT 3662 indicates that the majority of the cases were diagnosed at an early stage (i.e., local) of the disease rather than a later stage (i.e., regional or distant) of disease. In fact, when compared to the state of Massachusetts as a whole, more women in Wayland were diagnosed at an earlier stage of breast cancer (74% diagnosed at local stage in Wayland versus 62% diagnosed at local stage in Massachusetts). These data seem to suggest that Wayland residents use screening and early detection practices more often, resulting in a greater number of breast cancer diagnoses in this area.

Lung cancer among females was slightly elevated in the town as a whole and was statistically significantly elevated in CT 3661, where the Dow Chemical site is located. The distribution of smoking status among female lung cancer cases in both the town of Wayland and in CT 3661 revealed that the majority of cases (i.e., 68%) were current or former smokers at time of diagnosis. Therefore, it is possible that smoking played a role in the incidence of this cancer.

Review of the most recent available cancer incidence data for the year 1995 confirms that Wayland residents do not appear to be experiencing excessive or unusual rates of cancer. There were no statistically significant elevations among any of the fourteen cancer types reviewed for this year. Further, review of geographic location of cases diagnosed in 1995 revealed no apparent spatial pattern of cancer cases in either CT 3661 or CT 3362, nor did it reveal any spatial pattern in the area where the former Dow Chemical site is located.

B. Environmental Data

To determine whether individuals are exposed or could be exposed to contaminants detected onsite at Dow Chemical or possibly migrating from the site, the factors influencing human exposure were evaluated. Exposure pathways are identified as complete or potential. Completed pathways indicate that exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. Potential pathways, however, indicate that exposure to a contaminant may have occurred in the past or may occur in the future.

1. Completed Exposure Pathways

Surface Soil (0-3 inches) Pathway

Past exposures were possible to contaminants in the surface soil. Environmental sampling data indicate that some surface soil contamination existed on the site, particularly in the former burn bucket area, the former concrete pad area, and the former shallow disposal area. Because most samples were collected between zero and two feet below ground surface, the

proximity of the contamination to the ground surface (that is, within the first few inches of soil) is unknown. If the contamination is actually below the first few inches of soil, this would present less opportunity for exposure than if the contamination was at the ground surface.

Exposures to surface soil in the past were most likely for workers on the site. However, local residents have been reported walking on the site. Wayland residents used the site to access the walking path that winds through the wooded area. Historically, the site was not fenced and some residents have been reported in the developed area of the site. Therefore, possible exposure routes to surface soil include occasional incidental soil ingestion and dermal contact with the soil.

While there is evidence of non-employee use of the property, the evidence does not suggest that resident use of the site generally would result in significant opportunities for actual exposure. Occasional contact with surface soil could have occurred while walking on the site. However, due
to the industrial use of the site, activities that could result in significant exposure (such as young children contacting the surface soil while playing or older children disturbing the soil while riding dirt bikes) have most likely not occurred on the site.

Although it is possible that some exposure to residents from contaminants in surface soil at the Dow Chemical site may have occurred in the past, the majority of the compounds detected in the site surface soils were at concentrations below the ATSDR comparison value or within typical background concentrations. Although some compounds were detected at concentrations above the ATSDR comparison value, these compounds were found at depths ranging from two to four feet below ground surface. Given the types of activities that reportedly took place at the Dow site, it is unlikely that area residents were exposed to these compounds in the subsurface soil. In addition, some PAHs were detected above the ATSDR comparison value and rural/urban background concentrations. However, these compounds were detected in areas of the site at which soil removal and remedial activities have taken place and therefore do not reflect current site conditions.

Current and future exposures to on-site surface soils are not likely to pose a health threat to area residents. The site is planned for use as conservation land in the future. The types of activities that are expected to take place at the site (e.g., trail walking, hiking) are of low intensity with respect to contact with soils. As a result, the frequency that people will visit the site will be fairly low (e.g., one or two days per week for hours at a time). In addition, Because the site is planned for use as conservation land and because most of contaminated soils on the site were removed during remedial activities, it is not expected that exposure to residual levels of contamination in the soil would pose a health risk.

2. Potential Exposure Pathways

Subsurface Soil Pathway

Although some unknown compounds have been detected in subsurface soil from samples obtained from the shallow disposal area, most compounds were found to be either naturally occurring and/or related to the decomposition of plant material (e.g., pinenes, terpenes, natural waxes, steroids, and
fatty acid compounds) (Gradient 2000). These compounds were detected in samples obtained from a small isolated area of the site, which is heavily wooded, and not easily accessible to the public (Greene 1997). Although local residents have historically been known to visit the site (most often by the footpath which winds through the site), the primary activities that occurred were walking and/ or hiking. In addition, the public is typically only exposed to the top three inches of soil as a result of light recreational activities (i.e., walking, hiking). Due to the inaccessibility of the subsurface soils (i.e., soils found at least two feet below ground surface) to the general public, it is unlikely that local residents have been or would be exposed to site-related contaminants in the subsurface soil. It is possible that, in the past, Dow employees may have been exposed to subsurface soil contamination if they excavated the soil for any reason or disposed of waste below the ground.

Future and current exposure to subsurface soil contaminants could occur during intrusive activities for onsite remedial workers or future excavation or development of the site. The potential exposure routes would be incidental ingestion, inhalation of and dermal contact with subsurface soils. In the future, the site is planned for use as conservation land. As a result, the types of activities that are expected to occur on this property include activities such as trail walking and hiking. There are no current plans to re-develop the site. It is therefore unlikely that people would be exposed to subsurface soils during excavation or development activities in the future. It should also be noted that most of the contaminated subsurface soils found at the site have been removed. Although unlikely, if exposure to residual levels of contamination in the soil did occur, it is not expected that such exposure would pose a health risk.

Air Pathway

No historical environmental sampling data exist to determine whether exposures to contaminants in the air occurred. Therefore, there is insufficient information to accurately characterize possible exposures. Historical records indicate that small volumes (i.e. 100 gallons per year) of volatile solvents were allowed to evaporate up laboratory hoods during normal operations. In addition, employees reportedly burned solvents on-site in the burn bucket area. The former burn bucket area

was located in the northeastern most developed portion of the site and was not adjacent to or near the surrounding residential properties. It is possible that individuals walking on the footpath that winds through this area of the site may have been historically exposed to air particulates via inhalation if burning occurred while they were visiting the site. Dow reportedly engaged in this activity for a limited time period between the years 1964 to 1974. It is not known whether and to what extent individuals frequented the site during these years. It is possible that in the past, an individual(s), who visited the site when burning activities occurred, may have been exposed to airborne particulates as a result of this practice. However, review of employee reports and historical records for the Dow facility

does not indicate that air was a medium significantly impacted by site related activities. In addition, given the nature of the operations conducted at the Dow facility, it is unlikely that the majority of area residents were significantly exposed to air pollutants originating from the former Dow site. Therefore, although environmental sampling data are not available to completely characterize potential exposures, based on known information to date (i.e., employee reports, historical records, and the activities that reportedly occurred at the Dow facility), the MDPH does not believe that this pathway posed a public health hazard for the general population.

In response to community concerns raised at the public meeting held in June 1997, the MDPH obtained and reviewed meteorological data for the town of Wayland from the Northeast Regional Climate Center. Review of cancer incidence data evaluated in relation to prevailing wind data did not suggest an unusual pattern in relation to likely areas of air exposure.

Groundwater Pathway

Past, current, and future exposures to groundwater are unlikely. According to *the Method 3 Risk Characterization*, no public or private water supply wells are located within a one-mile radius of the site (Gradient 2000).

Groundwater sampling from the Willow Brook Farm property, located downgradient from the Dow site, was conducted in 1994 (GZA 1995). The Willow Brook Farm property is located in Wayland, south of and across Commonwealth Road from the Dow site, with its easternmost part in Natick.

This property is served by municipal water. Sampling of five monitoring wells located on the eastern portion of the property did not detect any VOCs or pesticides. According to the *Phase I Site Assessment*, although it is possible that groundwater contamination from the Dow site may impact groundwater at the Willow Brook Farm property, analysis of groundwater samples collected from this area does not suggest that contaminants from the

Dow site have migrated (GZA 1995). Because no potential receptors exist, and because the levels of contamination on the Dow site were below MDEP clean-up standards, the MDEP does not believe that off-property migration of the contaminants will present exposures that would pose a risk (MDEP 1998a).

Therefore, although future exposures to groundwater from the site can not be eliminated, it is highly unlikely that such an exposure would occur. According to the MDEP, the site is not located within a Potentially Productive Aquifer or any other active or potential drinking water source (Ransom 1999a, Ransom 1999c). In addition, the site is not located in or connected to a Zone II drinking water protection area or an interim wellhead protection area (Ransom 1999a). Therefore, there are no pathways such as water supplies, which could be impacted by the limited contamination detected. In addition, groundwater from the Dow site is expected to discharge into the wetland area south of the site. According to the MDEP, given the types of VOCs detected in the groundwater, and their fate and transport properties (i.e., the manner in which they breakdown and travel through the environment), it is very unlikely that they would ever migrate to potential drinking water wells and be present at concentrations exceeding drinking water standards (MDEP 1998a). Furthermore, the source of the groundwater contamination (i.e., contamination in the former shallow disposal area) has been removed from the site. Although uncertainty exists over how long the degradation process may take, contaminant levels in the groundwater, are expected to decrease over time (Ransom 1999b).

Surface Water and Sediment Pathway

As discussed in the Site Description section, three ponds exist on the property. *The Final Preliminary Assessment Report* reported that local children primarily used these ponds (pond name unspecified) for skating and hockey during the winter. Use of the pond(s) for wintertime activities would not typically result in opportunity for exposure unless someone fell in. If an individual
waded or swam in the ponds, exposure to surface water and sediment would be possible. However, based on review of site related historical data as well as anecdotal information

from the community, the ponds were primarily used for ice skating and occasional fishing. It is therefore unlikely that the ponds have been or will be used in the future for recreational purposes that would result in significant exposures. Review of environmental sampling data for the ponds do not suggest that occasional contact with surface water or pond sediment would result in significant opportunities for exposure likely to produce adverse health effects.

Individuals trespassing on the Dow site may have been exposed to the piles of dredged pond sediments if they came in direct contact with these piles (i.e., through dermal contact, incidental ingestion, or inhalation of fugitive dusts). However, based on reports from the community, the majority of individuals who visited the site, used the footpath that winds through toward the woods abutting the property. The MDPH has not received any reports of individuals climbing on or playing in these dredged piles and coming into contact with sediments as a result. Although the MDPH acknowledges that this exposure scenario is possible, based on information reported by the community and other sources, it seems unlikely that area residents took part in this type of activity. However, if such exposure did occur, the maximum detected concentration of the majority of compounds detected in the piles were below ATSDR comparison values and/or MDEP cleanup standards.

Current and future exposures to pond sediments and surface water are unlikely to pose a significant health risk to local residents. Currently, surface water and sediment in the ponds are impacted by low concentrations of SVOCs and metals. In fact, most compounds were detected at concentrations below background and/or below ATSDR comparison values and MDEP standards. In addition, according to a letter requesting that the site be removed from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list, the presence of these types of compounds in the ponds is thought to be primarily due to runoff originating from Route 30 (Ransom 2000e, 2000f). In addition, as part of the *Method 3 Risk Characterization*, health risks from swimming and wading in the ponds were calculated quantitatively and compared to MDEPs risk regulations. These risks were calculated for children (the most sensitive population) who may

swim or wade in the North Pond (the most contaminated and the most accessible of the three ponds). Under this exposure scenario, assuming incidental ingestion and dermal contact with both sediments and surface waters, the calculated health risks were below MDEP regulations (Gradient 2000).

Fish Consumption Pathway

Reportedly, in the past, a Dow employee stocked the North Pond with fish. It is not known whether and to what extent Dow employees consumed fish from the pond. Based on review of site related historical data, as well as anecdotal reports from the community, it does not appear likely that local residents regularly (i.e., three or more times per week) used the ponds on the Dow site property for fishing. While it is possible that one or two individuals may have fished in the ponds once or twice a week, this activity alone does not constitute exposure. For an individual to be exposed to contaminants via this pathway, one would need to consume the fish that was caught. Based on review of site historical information and anecdotal reports from the community, consumption fishing did not regularly occur at the Dow site.

C. Child Health Initiative

The ATSDR and MDPH, through ATSDRs Child Health Initiative, recognize that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their environment. Children are at greater risk than adults from certain kinds of exposure to hazardous substances emitted from waste sites. They are more likely exposed because they play outdoors and because they often bring food into contaminated areas. Because of their smaller stature, they may breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if certain toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

According to the Wayland community, children primarily used the ponds at the Dow site for ice skating in the wintertime. Participation in this activity would not result in an opportunity for exposure unless someone fell in. However, review of environmental sampling data does not indicate that exposure to concentrations of contaminants found in surface water or pond sediments would likely to result in health effects. Teenagers were known to use the site as a hangout area. Anecdotal information from the Wayland community suggests that in the past teenagers would drink alcohol near the former concrete pad area. Although this information indicates that teenagers were trespassing on the developed area of the site, the available evidence does not suggest that the reported use of the site would generally result in significant opportunities for actual exposure. Based on these reported uses of the site, activities that could have occurred while walking or hanging out on the site (e.g., incidental ingestion or inhalation of surface soil) do not appear likely to have occurred.

Review of age-specific cancer incidence data for the town of Wayland during the years 1982-1994, and 1995 did not indicate any unusual incidence patterns or increases in cancer incidence among children or teenagers residing in Wayland.

VII. LIMITATIONS

This investigation is descriptive in nature and can only provide a comparison of cancer incidence in census tracts in Wayland with cancer incidence in the state of Massachusetts. Descriptive assessments have certain inherent limitations. Only routinely collected data are analyzed and information about personal risk factors (such as smoking, occupation, and diet) which may influence cancer incidence are often limited and not of an historical nature. Because cancer is a legally reportable disease monitored through the MCR, these data can be evaluated to determine whether cancer is elevated in a specific geographic location. No such registries or statewide monitoring of non-cancer outcomes currently exist where data would be readily available for analysis. Therefore, these types of health concerns could not

be evaluated. It is beyond the scope of this investigation to determine any causal relationships and/or synergistic roles that risk factors may have played in the development of cancers in Wayland.

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VIII. CONCLUSIONS

- Standardized Incidence Ratios for the period 1982-1992 indicate that there were no statistically significant elevations of any cancer type analyzed in Wayland. All cancer types investigated occurred approximately at rates that would have been expected or slightly elevated compared to the statewide cancer incidence experience. Lung cancer occurred significantly less often than expected among males in the town of Wayland and CT 3662. Cancer incidence in CT 3661 (the area of the Dow Chemical site) was generally less than expected based on statewide cancer incidence.

- During the years 1987-1994, cancer incidence generally occurred at or near the expected rates and most cancer types occurred at approximately the same rates observed during the 1987-1992 time period.

- Breast cancer occurred more often than expected among females in the town of Wayland and CT 3662 during 1987-1994. The majority of the cases were diagnosed at an early stage, rather than a later stage of the disease. Since breast cancer screening improves breast cancer detection at an early stage of disease, this finding suggests that females in Wayland had access to and utilized breast cancer screening.

- During the years 1987-1994, lung cancer was statistically significantly elevated among females in CT 3661. Evaluation of smoking status information for these cases revealed that the majority (i.e., greater than 65%) were current or former smokers at time of diagnosis, suggesting that smoking may have played a role in development of this cancer.

- Review of 1995 cancer incidence data do not indicate an unusual or excessive pattern of cancer incidence among Wayland residents and analysis of the geographic distribution of cancer incident cases for all the cancer types investigated did not reveal any unusual pattern or clustering of cases. No unusual geographic pattern of cancer cases was observed in either CT 3661 or CT 3662.

- Based on the health outcome data reviewed in this assessment, it seems unlikely that an environmental exposure (specifically, contamination associated with the Dow site) was responsible for increased cancer rates in Wayland. This conclusion is based upon the fact that there was no discernible pattern of elevated rates of cancer and there was no evidence of geographic clustering in the area of the Dow site. Evaluation of exposure pathways from contaminants present at the Dow site do not indicate that significant exposures were likely to have occurred to local residents. In addition, although past exposures to surface soil contamination at the Dow site could have occurred, based on the available information, the magnitude and frequency of these exposures would not be expected to have resulted in significant health risks. Lastly, based on all the information provided and reviewed, it does not appear likely that private drinking water wells could be impacted by the site.

- ATSDR requires that one of five conclusion categories be used to summarize findings of a health consultation. These categories are as follows: (1) Urgent Public Health Hazard; (2) Public Health Hazard; (3) Indeterminate Public Health Hazard; (4) No Apparent Public Health Hazard; (5) No Public Health Hazard. A category is selected from site-specific conditions such as the degree of public health hazard based on the presence and duration of human exposure, contaminant concentration, the nature of toxic effects associated with site-related contaminants, presence of physical hazards, and community health concerns. Based on ATSDRs criteria, ATSDR would classify the Dow Chemical site in the past, present, and future as posing No Apparent Public Health Hazard. This finding is based upon the fact that numerous sampling activities have occurred at the site and many of the compounds detected were either below ATSDR comparison values or MDEP cleanup standards. For those compounds for which no standard or guidelines exist, or for those compounds that exceeded comparison values, based on information reported by the community and others, it does not seem likely that area residents would have been exposed to those compounds. Finally, review of health outcome data does not suggest that the site has adversely impacted public health across the general population. This category does not conclude that any one individual may not have had opportunity in

the past for exposure to the Dow site, but rather that the data reviewed indicates that the site posed no public health hazard to the general population.

IX. RECOMMENDATIONS

- The MDPH recommends that the Wayland Board of Health coordinate with the MDPH, Office of Tobacco Control to determine appropriate smoking intervention strategies for females in the town.

- The Massachusetts Cancer Registry routinely monitors the incidence of cancer in Massachusetts' cities and town. The MDPH/BEHA will continue to review published MCR reports on cancer incidence for the Wayland community to determine if any follow-up is warranted.

- Although significant exposures to residents from the Dow Chemical site were not likely to have occurred in the past, and are not likely to occur in the present, or future, the MDPH will review any additional environmental data for the site, as it becomes available upon the request of local officials or citizen representatives.

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