



**VERO BEACH CANCER REVIEW
INDIAN RIVER COUNTY**

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**Florida Department of Health
Division of Environmental Health
Bureau of Environmental Public Health Medicine**



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Executive Summary

Florida Department of Health (FDOH) concluded a review of cancer rates in Indian River County, the City of Vero Beach and the surrounding area served by municipal water in response to resident concerns. Contamination of the public drinking water system occurred in 1976-1979 (estimated) when a tank of trichloroethylene (TCE) at the Piper Aircraft facility leaked and reached a production well supplying city water.

This inquiry was designed to determine whether DOH could find evidence of elevated cancer rates in the community. In other words, whether the number of observed cancer cases in the community was higher than the number of expected cases based on cancer rates found within the state as a whole (the comparison population). The Florida Cancer Data System (FCDS) was the source for cancer data and the 1980, 1990 and 2000 Census provided the available published population data. The time period examined was 1981 to 2004, based on contamination of the public drinking water system for an estimated time period of 1977-1979 and a minimum period of follow-up of 25 years. The study focused on cancers most linked to TCE contamination which are liver, kidney, leukemias, non-Hodgkin's lymphoma and bladder cancers. Total cancers and lung cancers were also reviewed as comparisons.

A search of FCDS records for 1981 through 2004 identified 720 cancer cases of concern among all age groups in this Vero Beach area. Of these, 6 cases were among children (0-19 years). 4966 cases of all other cancers were noted during 1981-2004. Most cases were among older adults, the mean and median age of diagnosis was at least 70 years.

Analyses of cancer rates was restricted to the years 1981-2004, representing 25 years past estimated exposure time (theoretical latency). The analyses did not show increased rates for total cancers in the years encompassing 1981-2004. Analysis of lung cancer, a cancer not linked to TCE, also did not show increased cancer rates over expected in this time period in the study area.

Analyses for cancers most linked to TCE contamination suggested that the Vero Beach community experienced small increases in rates of leukemia in the period 12 to 25 years past the estimated exposure period of 1977-1979. Observed versus expected numbers produced slightly increased SIRs, all elevations were less than 2.0. These small increases in leukemia were not consistently seen across multiple periods in the analysis and cannot be positively attributed to any contamination event in prior decades. An increase was also noted in one period for bladder cancer some 10 years after estimated exposure but not in any other period. This increase cannot be positively attributed to any contamination event in the prior decades. The small increases observed in leukemias and bladder cancer rates could also be due to random fluctuation in rates. Increases in liver cancer, the cancer most strongly linked to TCE exposure, were not seen in this analysis. Increases in kidney cancer and non-Hodgkin's lymphoma were also not seen in the analysis.

No further actions or steps are recommended at this time. Additional study is not recommended for consideration to further understand the increases noted as increases were very small and increased rates of cancers of concern were not consistently seen. Exposure is no longer occurring in this community. Further investigation would not provide any additional data that would more conclusively associate TCE contamination of the public water supply and increases in cancer.

Background:

In the spring of 2008 a packet and letter came into the Florida Department of Health (FDOH), Bureau of Environmental Public Health Medicine (EPHM) requesting assistance in investigating a possible increase in cancers associated with contamination of the municipal water supply of the City of Vero Beach that had occurred decades past. The individual was a concerned citizen who indicated that although the spill and associated contamination of the water supply were documented there had not been any assessment of resident health. FDOH, EPHM, reviewed the packet of documentation supplied by the citizen, contacted the Indian River County Health Department (IRCHD) and called the regional Department of Environmental Protection (DEP) office to begin gathering information about the situation.

Additional information and clarification was sought through consultation with state toxicologists, the FDOH Bureau of Water Programs, the IRCHD and with Jeff Prather, Florida DEP (Orlando). For this inquiry, EPHM began an initial investigation and utilized existing published data to accomplish the review for the period 1981-2004. The Florida Cancer Data System (FCDS) and available census data (both available electronically to the Department) were the primary data sources for this cancer review.

The purpose of the cancer review was to determine whether there was an increased rate of cancer types known to be related to exposure to the chemicals of concern in the city of Vero Beach over what may be expected based on FCDS data during the time period 1981-2004. Although this includes a review of cancer rates for the city of Vero Beach, this type of assessment cannot be used to link a specific exposure to a health outcome such as cancer. In other words, causality cannot be established. Studies or reviews such as this cancer review presented here for the city of Vero Beach are not able to show a link between specific cancers and specific causes such as environmental contaminants.

Environmental Contamination Issues and Chronology:

Discussions concerning contamination of the area surrounding the Piper Aircraft facility are primarily based on files supplied by Jeff Prather of DEP related to the Piper site including subsequent monitoring and clean up activities. DEP and the IRCHD also supplied some information related to two additional small sites near the Vero Beach Airport but discovered decades after the Piper site. Documents supplied by a concerned citizen were also reviewed but did not contain any primary information referenced in this report. The contamination was first discovered in October 1978 in the City of Vero Beach's drinking water through routine testing. A private researcher hired to collect and test water samples for trihalomethane analyses discovered trichloroethylene (TCE) in the finished water sample (at the tap) of 68 ug/L. Subsequent testing of the finished water done by an independent group in November 1978 confirmed the results (67 ug/L TCE). After investigation, the city traced the source of the TCE to the City of Vero Beach Production Well (PW) 15. A concentration of 893 ug/L TCE was found in the well in November 1978. Contamination related to vinyl chloride, 1,1 dichloroethene, and cis/trans-1,2-dichloroethene was also noted in DEP records at this time. Subsequent testing of PW 15 produced TCE results of 980 ug/L in February of 1979. In 1987, the U.S. Environmental Protection Agency (EPA) adopted an MCL of 5 ug/L. In 1991 the state adopted an MCL of 3 ug/L.

The source of the contamination for PW 15 was traced to a leaking fitting on an underground storage tank (of approximately 5000 gallons) at the Piper Aircraft facility. This

is an eight acre site at the southern end of the Vero Beach Municipal Airport where assembly and painting of light aircraft began in 1957. Chemicals used in these operations were stored on-site and primarily in underground storage tanks. The tank was located approximately 850 feet from PW 15 and also in proximity to other production wells in this area (wells 16, 19, 20). The company indicated that the tank was first put into service on January 1977 although it may have been in-ground for a period prior to that as records indicate that tank installation at this site was either summer or fall of 1975 or 1976, and most often listed as installed in 1976. Widespread elevated levels of contaminants found in shallow wells near the leaky tank suggested that the tank had been leaking for some time. It was not possible to estimate exactly when the drinking water was contaminated but the fitting was assumed to have been a faulty installation and the tank to have been leaking since installation. Sophisticated modeling capabilities were not available at that time to estimate plume formation and movement.

It appears that some remedial efforts (local dewatering around PW 15) were undertaken in the spring of 1979 in an attempt to quickly remove contaminants. This was not successful and it was noted in documents that the contamination was suspected of being more substantial than first thought. Although there is not an exact date given in files provided, PW 15 was not taken offline until late spring of 1979 some 6 months or more after contamination was noted and verified. PW 15 was the most productive well for the City of Vero Beach with pumping estimates of 700 gallons per minute. All production wells pumped to a central distribution plant where water was subsequently treated and blended. The daily blending strategies were not available for this report but it was noted in records that finished water would have been blended from a number of wells, and that it is assumed that PW 15 was never the sole source of finished water for the city. Based on these parameters, there is the potential for the residents of the City of Vero Beach served by this water system to have been exposed to contaminated drinking water (from this source of contamination) for a period of time ranging approximately from a minimum of approximately 28 months to a maximum of 46 months.

In 1980, Piper and the FDEP signed a consent agreement to begin clean-up on the Piper Aircraft site and Piper began installing dewatering wells and monitoring wells. In 1981, based on FDEP enforcement actions an ongoing monitoring, testing and treatment program was put into place. In 1989 Piper also removed, treated and replaced contaminated soils in the area surrounding the tank. In 1990 this site was listed on the EPA Superfund National Priorities List (NPL) based on significant groundwater contamination. At the time of this report, remediation and monitoring activities are still on going on this site and clean-up is expected to take a number of additional years. Records indicate that PW 15 was placed back on line into service in 1992 with air strippers.

After being placed on the NPL list the FDOH did a health assessment (risk assessment) in December of 1988 and again in March of 1996. These documents may be found at http://www.doh.state.fl.us/environment/medicine/SUPERFUND/pdf/1988/piperaircraftco_ph_120988.pdf and <http://www.doh.state.fl.us/environment/medicine/SUPERFUND/piperupdate.pdf>. In the 1988 report, Florida HRS reviewed the existing environmental data at the Piper NPL site in Vero Beach including evidence of onsite TCE contamination. They concluded the site was a potential health threat and that the then current measures for groundwater and air testing were inadequate. Florida HRS recommended air monitoring, more groundwater testing, and a survey of nearby private wells. In a 1996 update, Florida HRS concluded groundwater

testing since 1988 was adequate and that no further investigation was needed based on ground water use.

Understanding the full extent of contamination related to the Vero Beach municipal water supply is complicated by the finding of two small additional sites of contamination near the airport. A second area of contamination (primarily contaminated with TCE) was discovered in 1981 in an area known as "Stump Dump" while completing a new supply well, PW 23. The Stump Dump area is near by the original area of contamination. Remediation at the Stump Dump site began in 1986. A third area of contamination has also been recently noted in the general area of Vero Beach separate from the Piper Aircraft site or the Stump Dump site. The South Gifford Road Landfill Site is also undergoing remediation efforts. The source of contamination for this proximal site is assumed to be long buried tanks (TCE) or debris and has not been positively identified. Indian River County water has been provided to the impacted businesses and residents who were using private wells affected by the contamination at South Gifford Road Landfill Site.

In summary, PW 15 was documented to have very high levels of TCE in 1978. Notations also exist in the files received from DEP that at some time Wells 15, 16, 17, 18, 22, 23, 24, 28, C1, C2 and C3 were all contaminated to some extent and were required to pump through an air stripper before incorporation into the finished water supply. This notation is undated but was entered prior to 1993 in the drinking water database. Source of contamination for these additional well contaminations is not consistently noted in the files but is outside the scope of this inquiry.

Sampling results for the finished water supply are limited and very few data points were provided by DEP for this report. Limited sampling results begin in 1985. Of the limited sampling results available for 1985 onward, no results showed detectable levels of the volatile chemicals of concern in the Vero Beach drinking water. Based on these water sampling data, it would appear that efforts by the utility were successful in minimizing or eliminating TCE and other volatile organic compounds (VOCs) from the finished water supply.

Given the very long time frame under study, the multiple contamination sites involved and ongoing remediation efforts, a comprehensive description of all sources of contamination, remediation efforts and related sampling results is outside of the scope of this cancer review. Thousands of pages of documents related to sampling consent orders, remediation plans, progress reports and subsequent studies exist on these sites. The Piper Aircraft site resulted in limited but documented contamination of the City of Vero Beach water supply and documents related to this site's clean up efforts may be found at <http://www.epa.gov/region4/waste/npl/nplfls/piperaf1.htm>. Neither the Stump Dump Site nor the South Gifford Road Landfill Site are designated as NPL sites.

Map 1 provides locations of production wells, of Piper Aircraft, of Stump Dump site and of the South Gifford Road Landfill site.

Florida Cancer Data System (FCDS) Review:

The Florida Cancer Data System (FCDS) was established in 1981 and contains information on cancers diagnosed since then through 2008 (at the time of this report the 2008 data are available but still considered provisional). Hospitals, free standing ambulatory care centers,

radiation therapy facilities, pathology laboratories, physician offices and dermatopathologists offices are required to report incidence data to FCDS. The FCDS is an award winning cancer registry, receiving the highest level of national certifications possible which reflects meeting or exceeding national standards for data accuracy, completeness and timeliness of reporting. The FCDS serves as the repository of cancer data for Florida residents. Over the years, numerous steps have been taken to improve the completeness of the data set, the timeliness of the reporting, the number of facilities required to report and the types of cancers reported. Hospital discharge data, ambulatory surgical center data and death certificate data are also linked with FCDS on an annual basis in order to identify any possible missing cases. FCDS annually also links with data provided by the Florida Association of Pediatric Tumor Programs (FAPTP) in order to assure all pediatric cancers known to FAPTP are represented in FCDS.

There are a few exceptions to the broad reporting requirements for cancer in Florida; a few of these may have some relevance in this investigation and are listed below:

a. Data on non-melanoma skin cancers are generally not reported to FCDS. This is not a cancer of concern in the Vero Beach analysis but as some analyses have been examined for 'all cancers' this exception is noted.

b. Reporting of some early stage in-situ cancers, such as early stage cervical cancer, is also not thought to be complete and thus early stage cervical cancers are not included in this analysis. Early stage cervical cancer is not a cancer of concern in the Vero Beach analysis but as some analyses have been examined for "all cancers" this exception is noted.

c. Veteran Administration hospitals (VAs) are not required to report to FCDS. FDOH routinely receives records from military facilities (bases). Vero Beach residents who received health care solely through a VA facility (not military base care) may not be represented in FCDS records (<http://www.fcds.med.miami.edu>).

Other Facts about FCDS and Cancer Rates:

FCDS contains data on Florida residents only and thus former Florida residents who move out of state and are then diagnosed with cancer after they are considered residents of other states may not be present in the registry. Individuals who move into the area with a subclinical cancer already in place (not yet diagnosed) are counted as incident cases related to their new residence. Some states do reciprocate and provide data to FCDS on Florida residents who are diagnosed with and receiving care in other states.

Persons with multiple primary cancer diagnoses contribute multiple records to the data base, meaning there is an individual record for each instance of primary cancer diagnosis and one individual may contribute more than one record. As an example, an individual diagnosed with primary liver cancer and with primary lung cancer would contribute two separate records to FCDS. Some cancers are known to metastasize to other parts of the body. In these situations, the cancers are recorded by FCDS based on the primary site of cancer only and are not counted as a case of cancer based on the anatomical site the cancer has spread to.

All records list the date of the initial diagnosis for the primary cancer and all records contain the address at the time of diagnosis as well as the current or last known address.

Residence history (time lived in a community or at a particular address) is not found in FCDS or in any other vital statistics record.

In addition, records are unduplicated thus there exists only one record for each individual primary cancer, regardless of the number of sources (such as laboratories, physician offices, hospitals) that report the case.

Cancers of Concern:

Overall, the four most common types of cancer in the US are lung/bronchus, prostate, breast and colorectal cancers. Florida shares this same pattern. In general, whites have a higher incidence of most cancer types. Cancer rates, stage of cancer at diagnosis, survival rates, and types of cancer vary by age, by sex and by race and all of these components have changed over the last decades with changes in medical practices and in treatments.

This report focuses on possible health effects related to trichloroethylene (TCE) because its concentrations and theoretical increased cancer risk were higher than any other contaminant. City of Vero Beach residents may have used contaminated water (drinking, bathing and cooking) for an estimated period of between 28 and 46 months at a concentration many times the drinking water maximum contaminant level (MCL). Exposure to TCE at these levels for this period of time may have produced a very low increased theoretical risk of liver cancer, kidney cancer, leukemia, and lymphoma.

Based on literature review and data available from EPA and ATSDR, TCE is most strongly linked to liver cancers based on toxicology data and occupational studies. Less strongly linked have been kidney cancers, non-Hodgkin's lymphoma, and leukemia in children. Weak links have been suggested for bladder cancer and very weak links have been suggested for TCE and prostate and cervical cancer, although the evidence for these is neither strong nor consistent (ATSDR, 1997; ATSDR, 2004; NRC, 2006; Schottenfeld and Fraumeni, 2006; US EPA, 2001; Wartenberg, Reyner, Scott, 2000).

There were a few additional contaminants noted in some DEP records associated with the Vero Beach sites (vinyl chloride monomer, 1,1 dichloroethene, and cis/trans-1,2-dichloroethene). Vinyl chloride is a degradation product of TCE and has similar health outcomes as TCE, although angiosarcoma of the liver is most particularly linked to vinyl chloride monomer exposure. Sampling results for these other contaminants were not documented or noted in the records associated with drinking water for years prior to 1985 (when limited sampling results were found) and therefore it is not relevant to explore health risks associated with these chemicals in this report. Presence of these other contaminants are noted on site in DEP records but are not documented in the drinking water. As previously stated, environmental sampling results for finished drinking water beginning in 1985 did not find any notable contamination.

The contamination situation described in this report involved access to limited sampling results. FDOH reviewed information from a number of sources, including animal toxicological studies, and the cancers of concern chosen may represent a broader list than would be chosen if the exact exposure doses for City of Vero Beach residents over time were known. The following cancers were identified as possible cancers of concern: liver, kidney, non-Hodgkin's lymphoma, leukemia, and bladder cancer.

Determination of the Geographic Area:

For the FDOH review of the cancer data for the Vero Beach area a determination of the geographical areas and boundaries was first made based upon the parcel designation for the area obtained from the Florida Department of Revenue (zoning map). The parcel designations are most often used for zoning, building and permitting purposes but first served to define the area. The parcel designation does not have population estimates associated with it. In addition, the distribution system for the public water supply (the City of Vero Beach municipal water supply) was also consulted. The public water supply provides water to Vero Beach, South Beach and Indian River Shores. The corresponding zip codes (32966, 32960, 32963 and 332964) were explored and determined to encompass an area much larger than the actual city of Vero Beach or of the area served by the public water supply. Census designations for the city and public water supply (2000 census data) were also explored and found to correspond to census tract boundaries. These census tracts also corresponded to the areas of distribution for the public water supply. Seven census tracts were used to describe the area of concern and for population estimates (City of Vero Beach, Indian River Shores, South Beach) for this analysis. Map 2 provides a description of the area of analysis including the City of Vero Beach, Indian River Shores and South Beach.

The City of Vero Beach Community:

Vero Beach is a city in Indian River County comprising approximately 13 square miles. According to the U.S. Census Bureau's 2006 estimates, the city had a population of 16,939. There are approximately 8500 households in the city, and the population is predominately white (93%) with 6% Hispanic ethnicity and with over 54% of the population being 45 or older.

It is the county seat of Indian River County and is a popular retirement area in the state. Restrictive zoning has deterred high rise buildings and large commercial and retail developments; the area has retained a residential quality. In addition to Piper Aircraft, major industries include tourism and citrus packaging.

Settlers began arriving in the area in the 1840's and settlers increased with the building of Flagler's Florida East Coast Railway. The city itself was built during 1912-1914 after draining of lands in that region and chartered as a city in 1919. In 1925, Indian River County was formed and in these post World War I years the city began to grow. The airport was built in the 1930's and was heavily used as a Naval Air Station during World War II. Rapid growth occurred in the area in the 1950-1960's in particular.

Population Data:

Population by age group, race, and gender were pulled from the 1980, 1990, and 2000 US census data. Linear interpolation was used to calculate intercensal years. The years 2001-2004 were estimated using population growth information obtained from the Florida Population Estimates for Counties and Municipalities, April, 1, 2008. The total population of the study area (whites only) was 17,911 for 1980, 21,589 for 1990, 23,215 for 2000 and 23,569 by 2004.

FCDS Data Search:

Local post offices were contacted and zip codes for the City of Vero Beach including catchment areas for Post Office boxes were noted. The FCDS was searched for cancer cases occurring among residents of the city of Vero Beach based on four relevant zip codes as broad catchments areas for the period 1981-2004 (32966, 32960, 32963 and 32964). FCDS was also searched by place name for residence including Vero Beach, Indian River Shores and South Beach. All cases of cancer having any patient address within the four zip codes broadly defining the City of Vero Beach or having Vero Beach, Indian River Shores or South Beach as the city name were pulled and then further geocoded to the area.

Once cancer cases for the period 1981-2004 were selected from FCDS based on the general area (zip codes and place names), addresses were further geocoded using Arc GIS in order to be identified as being within or outside the study area. Only those cases geocoded to be within the public water supply census blocks were included in the analysis. Every attempt was made to geocode each record. Of note, residents whose cancers were diagnosed after leaving the City of Vero Beach area, who were diagnosed and treated solely in a VA facility, and those who did not seek and receive confirmed diagnoses would not be present in the data set.

Vero Beach Analysis:

The primary focus of this report involves malignant cancers (leukemia, Non-Hodgkin's lymphoma, kidney, liver and bladder) for the period 1981-2004 representing 25 years past estimated exposure time (theoretical latency for cancer). As another analysis tool, lung cancer and a category 'all other cancer' (all cancers excluding the 5 cancer types of concern) were also examined for the general population in order to better understand the overall cancer burden of the community. As the population of Vero Beach and Indian River County is predominately white, results by race are not presented. All rates were age adjusted. For purposes of comparison, rates for the state of Florida (whites) were used to produce expected counts of cancer.

In assessing whether the area had experienced an increase in certain types of cancer, Standard Incidence Ratios (SIRs) were used. This involves comparing the observed number of cancer cases to a number that would be expected if the community were experiencing the same rate of cancer as a larger comparison area (in this case the state of Florida). These rates were multiplied by the population in the census tracts of concern. Population estimates for the three areas (Vero Beach, Indian River Shores, South Beach) were obtained from the 1980, 1990 and 2000 census (census tract data where available) and extrapolated between census years based on documented growth for each of these areas. This calculation results in the expected number of cancer cases in the Vero Beach area. The observed number of cases in the Vero Beach area was then divided by the expected number of cases in the Vero Beach area. This ratio of observed over expected is called an SIR. All rates (and the SIRs) in this study were age-adjusted. The SIR is considered elevated when it is over 1.0. It is considered statistically significant if the 95% interval between the lower and higher confidence limits does not include 1.0. As an example, if 100 cases are observed and 25 cases would be expected based on comparison rates, the SIR would be 4 (100/25). This elevation would be considered statistically significant if the lower confidence limit surrounding this are at least 1.1 (does not include 1.0) (Breslow and Day, 1993).

Results: General

An FCDS search for cancers in the Vero Beach area found 720 cases of cancers of concern (liver, kidney, bladder, leukemia, or non Hodgkin lymphoma) in the period 1981-2004 among all age groups. The mean and median age at diagnosis for all of these cancer types in this population was approximately 70 years of age or older. The majority of cases occurred among males (n=477). Data are shown in **Tables 1-2**. Only 6 cases of cancers of concern occurred among children age 0-19 in these years. As expected the majority of pediatric cases were leukemias (n=4). An additional 4,966 cases of all other cancers (all cancers but the five cancer types of concern) were found for residents geocoded to the Vero Beach, Indian River Shores or South Beach area for the period 1981-2004.

Comparisons were made to state rates in three year periods for each of the cancer types of concern. The rate for a three year period is an averaged simple weight of rates for each year in the three year period. As the area of concern is primarily of white race, all values and comparisons were based on population counts and rates among whites. All rates were age-adjusted. Computation of the observed number of cancer cases over the expected number of cancer cases yielded a SIR for each of the three year time periods. For brevity, computations are shown in **Tables 3 – 8** for three year time periods from 1981-2004 (25 years past exposure). Analysis results are presented ending in year 2004 as this approximately represents a sufficiently long theoretical latency period for cancers of concern.

Examining the category 'all other cancer', no three year period exhibited a markedly elevated SIR when compared to expected rates in the state as a whole (**Table 3, Graph 1**). In order to further explore cancer rates for this area, lung cancer rates (a cancer not linked to TCE exposure) were reviewed separately as well. No elevations in SIRs were seen in any of the three year time periods in the comparison to state values.

Results: Cancers of Concern

Observed versus expected comparisons for **Liver** cancer for the three year time periods did not produce elevated SIRs in the comparison to state of Florida values (**Table 4, Graph 2**). The overall review of the 25 year period does not appear to indicate an increase in liver cancer in the population of Vero Beach served by the municipal water supply.

Observed versus expected comparisons for **Kidney** cancer for the three year time periods did not produce elevated SIRs in the comparisons to state of Florida values (**Table 5, Graph 3**). In summary, no increase in kidney cancer rates was observed for this area spanning the period 1981-2004.

Observed versus expected comparisons for **Non-Hodgkin Lymphoma** for the three year time periods did not produce elevated SIRs in the state of Florida comparison (**Table 6, Graphs 4**). There appears to be no increase in overall rates for Non-Hodgkin lymphoma in the period 1981-2004 in this area.

Observed versus expected comparisons for **Leukemia** for the three year time periods produced two periods of elevated SIRs in the comparison to state values. These three year periods included years 1993-1995 and 2002-2004 where evidence of elevated SIRs are shown in **Table 7 and Graph 5**. The SIR in 1993-1995 was 1.69 when 29 cases of

leukemia were observed and 17.17 cases were expected (confidence limits of 1.13, 2.43). The SIR in 2002-2004 was 1.57 when 28 cases of leukemia were observed and 17.8 cases were expected (confidence limits of 1.04, 2.27). In summary, a small increase in rates of leukemia may have occurred in the early to mid 1990's and again in early 2000 in this population.

Observed versus expected comparisons for **Bladder** cancer for the three year time periods produced an increased SIR in the years 1987-1989 in the comparison to the state of Florida (**Table 8, Graph 6**). The SIR in 1987-1989 was 1.4 when 48 cases were observed and 34.19 were expected (95% confidence limits of 1.03, 1.86). In summary, a very small increase in bladder cancers may have occurred in the late 1980's in this population. The latency period (the period between exposure to TCE and cancer diagnosis) is somewhat short (less than or equal to 10 years) and it is not possible to determine if this may have been related to TCE exposure of the population in the late 1970's.

Limitations:

This analysis was conducted as an initial investigation of data associated with a possible increase in cancer in the Vero Beach area.

Some of the cancers explored actually comprise a group of diseases with many specific types diagnosed in the Vero Beach area (such as leukemia). Lumping of these different types for analysis purposes may not make sense from a medical/ biological perspective and it is likely that the risk factors for one type are not the same as risk factors for another. Although all of the cancers of concern were chosen based on toxicological and epidemiological evidence suggesting possible associations with TCE exposure, there are many other known and hypothesized risk factors for these cancers. Other risk factors include family history and genetics, ionizing radiation, exposure to other chemicals, occupational exposures, smoking, alcohol use, and diet and lifestyle issues.

Residence history is also not determined at this level of investigation which is limited to review of existing data bases. Therefore, long term residents who have moved away and are then diagnosed with cancer will be missed from this type of analysis. Residents new to the Vero Beach area who are then diagnosed with cancer will be counted as resident cases, regardless of the time that they have been living in the area and in spite of the fact that any relevant exposures were most likely from outside of the Vero Beach area. Seasonal residents who may have had intermittent exposure and who maintain residences in another area or state would most likely be missing from the case counts of cancer as well as denominator data. Given the very long time period under review and the enormous amount of in- and out-migration that may have occurred in the area since the late 1970's this inability to assume a stable population is a major limitation.

Few sampling points for finished water exist during this long time period and many assumptions about contamination and exposure have been made. The entire population served by the municipal water supply was assumed to be exposed at equal levels for the time period 1976-1979 and contamination is assumed to have stopped with the closing of the contaminated PW 15. It is not clear from the records provided if all contamination events are captured in the historical documents. Contamination may have theoretically continued in the period from 1979 until 1985 (when water sample results are provided) through city use of production wells not yet known to be contaminated but any cancer cases related to

exposure during the period 1979 to 1984 would most likely be diagnosed and be represented during the study period (1981-2005). All residents are assumed to have used this public drinking water supply for their drinking water and for showering and household uses. No additional data relevant to resident exposure were available for this review.

Cancer is a disease that takes a number of years to develop between initial exposure time or initial trigger and the diagnosis, including signs and symptoms. This latency period may be affected by the type of cancer in question, the age, sex and race of the individual and other contributing factors, such as smoking status. Many cancers have a latency period of 15-20 years and in some cases latency may be 25 to 30 years. Again, population movements during this time greatly impact the ability to interpret any findings.

Personal interviews, surveys, questionnaires and any other method of gathering exposure or other risk factor information specific to each case or to residents in general are not recommended in a preliminary investigation. These types of questionnaires are also not recommended when the investigation does not find consistent increases in cancer rates.

Limiting the study area to the census tract areas that generally comprise the area supplied by the municipal water supply may be a somewhat inexact boundary for this concern. Although the census tracts chosen generally corresponded to the area supplied by city water there may be slight differences in boundaries which cannot be ascertained in an historical analysis such as this.

A serious limitation to this finding is the inability to determine that the population in which the increases were observed (in other words residents of the Vero Beach area in 1990-1996) represents the same group of individuals who were in fact exposed in the late 1970's. Given the large influxes in growth and development, including retirement communities and general neighborhoods, in the Vero Beach area in the 1980's it is not possible to say with confidence that they are in fact the same group of individuals. The findings of small increases in selected cancer rates (bladder cancer and leukemias) during the period 10-25 years past exposure (within the latency period) are suggestive that the population may have experienced some portion of this increase as a result of a common exposure. However, there are far too many unknowns to state with certainty that increases seen are reflective of TCE exposure. It is more likely that the small increases observed could also be due to chance variation of rates, particularly as the increases observed were very small and not consistent across multiple years.

Conclusions:

In conclusion, there were very small increases in rates for two of the cancers of concern. A small increase in rates was seen for bladder cancer during the late 1990's. A small increase in rates was noted for leukemias in the mid 1990's and again in the early 2000's. No increases were observed for non-Hodgkin's lymphoma and kidney cancer. No evidence of an increase in liver cancer was observed; liver cancers are most strongly linked to TCE exposure.

The results of this cancer review suggest:

- **FCDS successfully provided the data needed to address the cancer concerns in the Vero Beach area served by the municipal water supply cancer review.**

- **The Vero Beach community experienced small increases in rates of leukemia, and bladder cancer 10 to 25 years past the estimated exposure period of 1976-1979. Observed versus expected numbers produced slightly increased SIRs, all elevations were less than 2.**
- **These slight increases were not observed consistently across the study period and cannot be positively attributed to any contamination event in prior decades. Observed increases could also be due to chance variation in rates.**
- **The All Cancer rates were not elevated.**
- **Cancer rates for lung cancer, not linked to TCE exposure, did not show increases in the period 1981-2004.**
- **This community is not experiencing ongoing contamination and exposure and any increase in cancer due to this exposure would have occurred within the study period ending in 2004.**

Recommendations:

Further study is not recommended for consideration to further understand the increases noted. Increases were very small and increased rates of cancers of concern are not consistently seen for the community. Exposure is no longer occurring in this community.

Further investigation would not provide any additional data that would more conclusively associate TCE contamination of the public water supply and increases in cancer. Detailed information for population migration and results for finished water samples in the period 1975-1980 are not available.

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Table 1. Cancer of concern case count by gender for residents of the Vero Beach Public Water Supply area, 1981-2004

| | Male | Female |
|----------------|------|--------|
| Bladder Cancer | 294 | |
| | 223 | 71 |
| Kidney Cancer | 103 | |
| | 71 | 32 |
| Liver Cancer | 25 | |
| | 17 | 8 |
| Leukemia | 131 | |
| | 74 | 57 |
| NH-Lymphoma | 167 | |
| | 92 | 75 |

Table 2. Count of cancers of concern by year of diagnosis for residents of the Vero Beach Public Water Supply for 1981-2004

| | Cancer type | | | | | Total |
|-------|-------------|--------|----------|-------|------------|-------|
| | Bladder | Kidney | Leukemia | Liver | NHLymphoma | |
| 1981 | 8 | 3 | 0 | 0 | 2 | 13 |
| 1982 | 10 | 2 | 2 | 1 | 1 | 16 |
| 1983 | 6 | 0 | 2 | 0 | 0 | 8 |
| 1984 | 13 | 4 | 1 | 0 | 4 | 22 |
| 1985 | 14 | 2 | 5 | 0 | 4 | 25 |
| 1986 | 14 | 6 | 3 | 0 | 4 | 27 |
| 1987 | 15 | 2 | 3 | 1 | 5 | 26 |
| 1988 | 19 | 3 | 5 | 0 | 2 | 29 |
| 1989 | 14 | 1 | 3 | 0 | 5 | 23 |
| 1990 | 11 | 7 | 2 | 1 | 9 | 30 |
| 1991 | 12 | 7 | 4 | 1 | 11 | 35 |
| 1992 | 7 | 8 | 5 | 1 | 10 | 31 |
| 1993 | 12 | 5 | 4 | 2 | 8 | 31 |
| 1994 | 15 | 3 | 15 | 2 | 9 | 44 |
| 1995 | 6 | 7 | 10 | 2 | 12 | 37 |
| 1996 | 15 | 2 | 6 | 0 | 6 | 29 |
| 1997 | 12 | 11 | 6 | 1 | 10 | 40 |
| 1998 | 11 | 5 | 7 | 5 | 9 | 37 |
| 1999 | 9 | 4 | 9 | 0 | 7 | 29 |
| 2000 | 12 | 3 | 6 | 1 | 13 | 35 |
| 2001 | 11 | 7 | 5 | 0 | 11 | 34 |
| 2002 | 16 | 2 | 10 | 2 | 14 | 44 |
| 2003 | 12 | 3 | 11 | 2 | 7 | 35 |
| 2004 | 20 | 6 | 7 | 3 | 4 | 40 |
| Total | 294 | 103 | 131 | 25 | 167 | 720 |

Table 3 and Graph 1: Age-adjusted 3 year SIRs with 95% confidence limits (CL) for All Other Cancers (all cancers except cancers of concern) in white residents of Vero Beach Public Water System area compared to state of FL whites (Years and rates with minor elevations highlighted in yellow)

| Cancer Type | Year(s) | Observed | Expected | SIR | Lower 95% CL | Upper 95% CL |
|-------------------|-----------|----------|----------|------|--------------|--------------|
| All Other Cancers | 1981_1983 | 356 | 373.4 | 0.95 | 0.85 | 1.06 |
| | 1984_1986 | 420 | 427.12 | 0.98 | 0.89 | 1.08 |
| | 1987_1989 | 503 | 488.41 | 1.03 | 0.94 | 1.12 |
| | 1990_1992 | 663 | 616.16 | 1.08 | 1.00 | 1.16 |
| | 1993_1995 | 632 | 617 | 1.02 | 0.94 | 1.11 |
| | 1996_1998 | 615 | 647.99 | 0.95 | 0.88 | 1.03 |
| | 1999_2001 | 596 | 674.41 | 0.88 | 0.81 | 0.96 |
| | 2002_2004 | 588 | 619.22 | 0.95 | 0.87 | 1.03 |

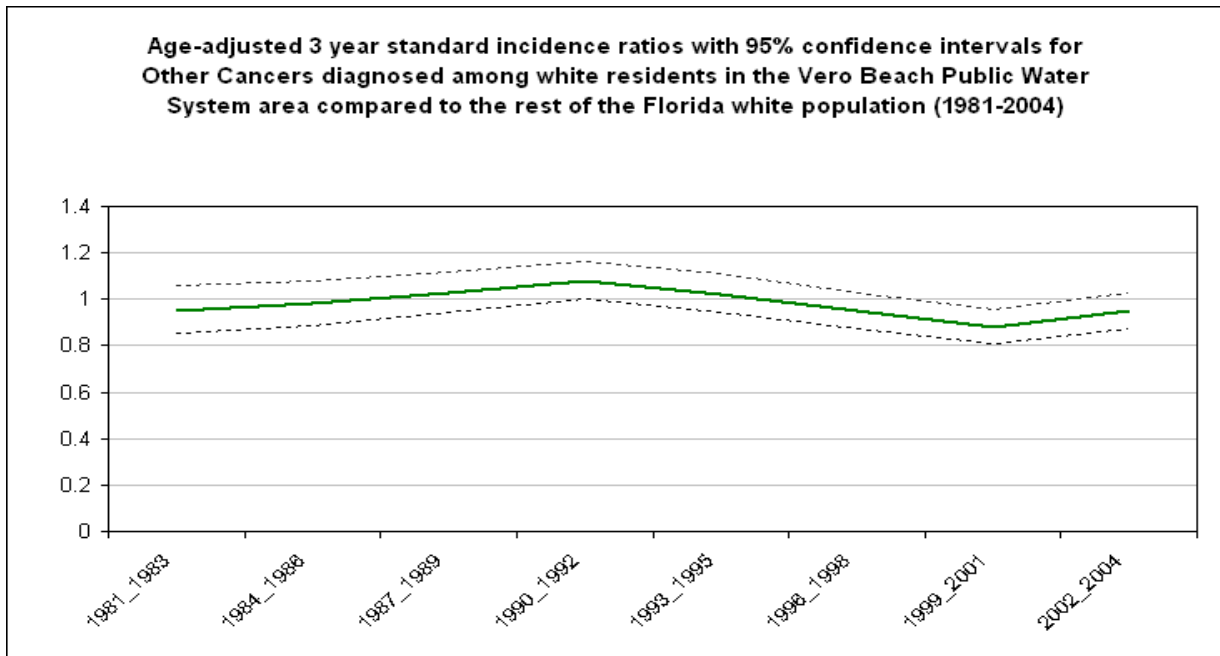


Table 4 and Graph 2: Age-adjusted 3 year SIRs with 95% CL for Liver cancers in white residents of Vero Beach Public Water System area compared to state of FL whites (Years and rates with minor elevations highlighted in yellow)

| Cancer Type | Year(s) | Observed | Expected | SIR | Lower 95% CL | Upper 95% CL |
|-------------|-----------|----------|----------|------|--------------|--------------|
| Liver | 1981_1983 | 1 | 1.75 | 0.57 | 0.01 | 3.18 |
| | 1984_1986 | 0 | 2.21 | 0 | 0.00 | 0.00 |
| | 1987_1989 | 1 | 2.44 | 0.41 | 0.01 | 2.28 |
| | 1990_1992 | 3 | 3.89 | 0.77 | 0.15 | 2.25 |
| | 1993_1995 | 6 | 4.56 | 1.31 | 0.48 | 2.86 |
| | 1996_1998 | 6 | 5.68 | 1.06 | 0.39 | 2.3 |
| | 1999_2001 | 1 | 6.35 | 0.16 | 0.00 | 0.88 |
| | 2002_2004 | 7 | 6.84 | 1.02 | 0.41 | 2.11 |

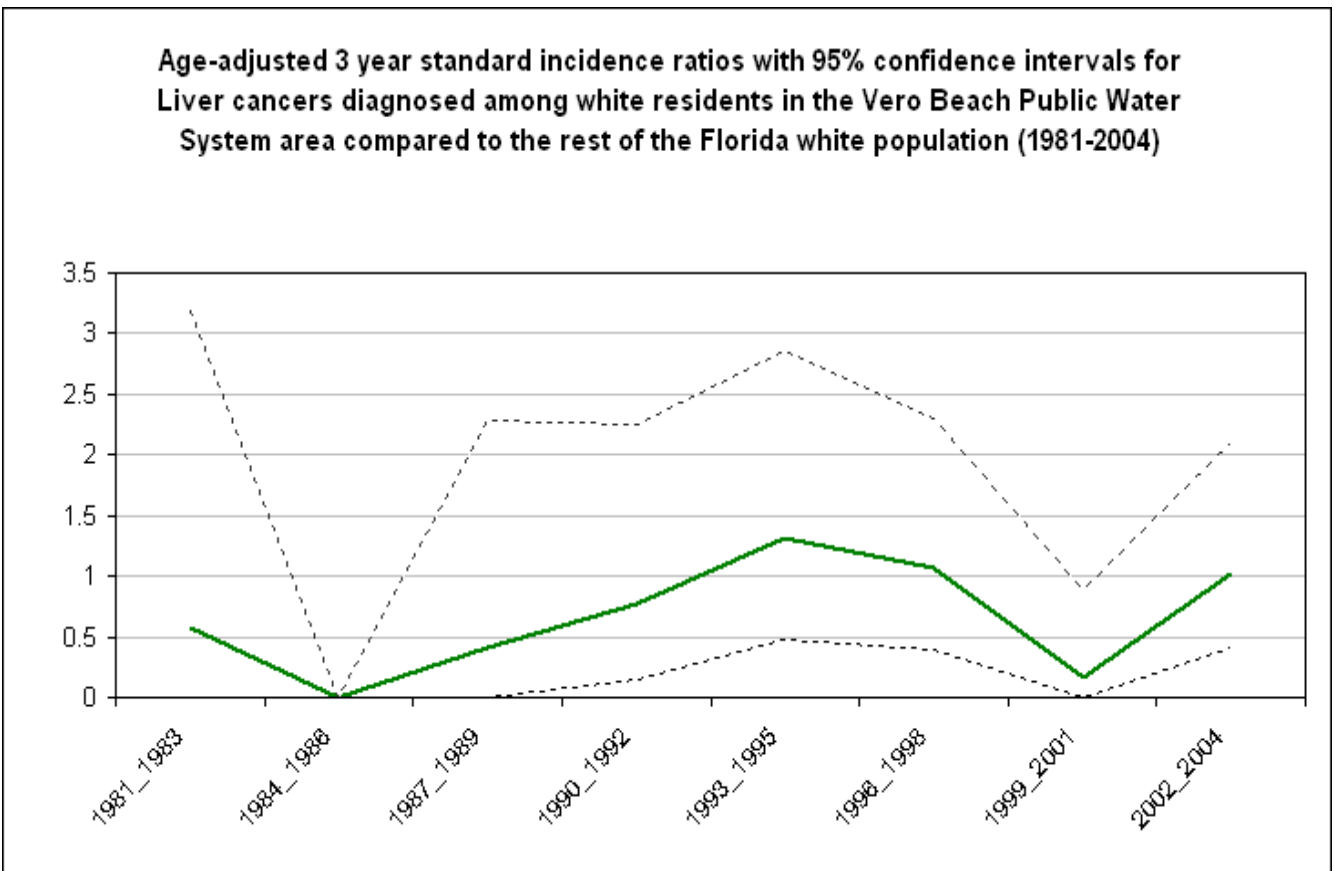


Table 5 and Graph 3: Age-adjusted 3 year SIRs with 95% CL for Kidney cancers in white residents of Vero Beach Public Water System area compared to state of FL whites (Years and rates with minor elevations highlighted in yellow)

| Cancer Type | Year(s) | Observed | Expected | SIR | Lower 95% CL | Upper 95% CL |
|-------------|-----------|----------|----------|------|--------------|--------------|
| Kidney | 1981_1983 | 5 | 8.91 | 0.56 | 0.18 | 1.31 |
| | 1984_1986 | 12 | 10.54 | 1.14 | 0.59 | 1.99 |
| | 1987_1989 | 6 | 12.41 | 0.48 | 0.18 | 1.05 |
| | 1990_1992 | 22 | 15.71 | 1.4 | 0.88 | 2.12 |
| | 1993_1995 | 15 | 15.67 | 0.96 | 0.54 | 1.58 |
| | 1996_1998 | 18 | 17.65 | 1.02 | 0.60 | 1.61 |
| | 1999_2001 | 14 | 19.4 | 0.72 | 0.39 | 1.21 |
| | 2002_2004 | 11 | 20.78 | 0.53 | 0.26 | 0.95 |

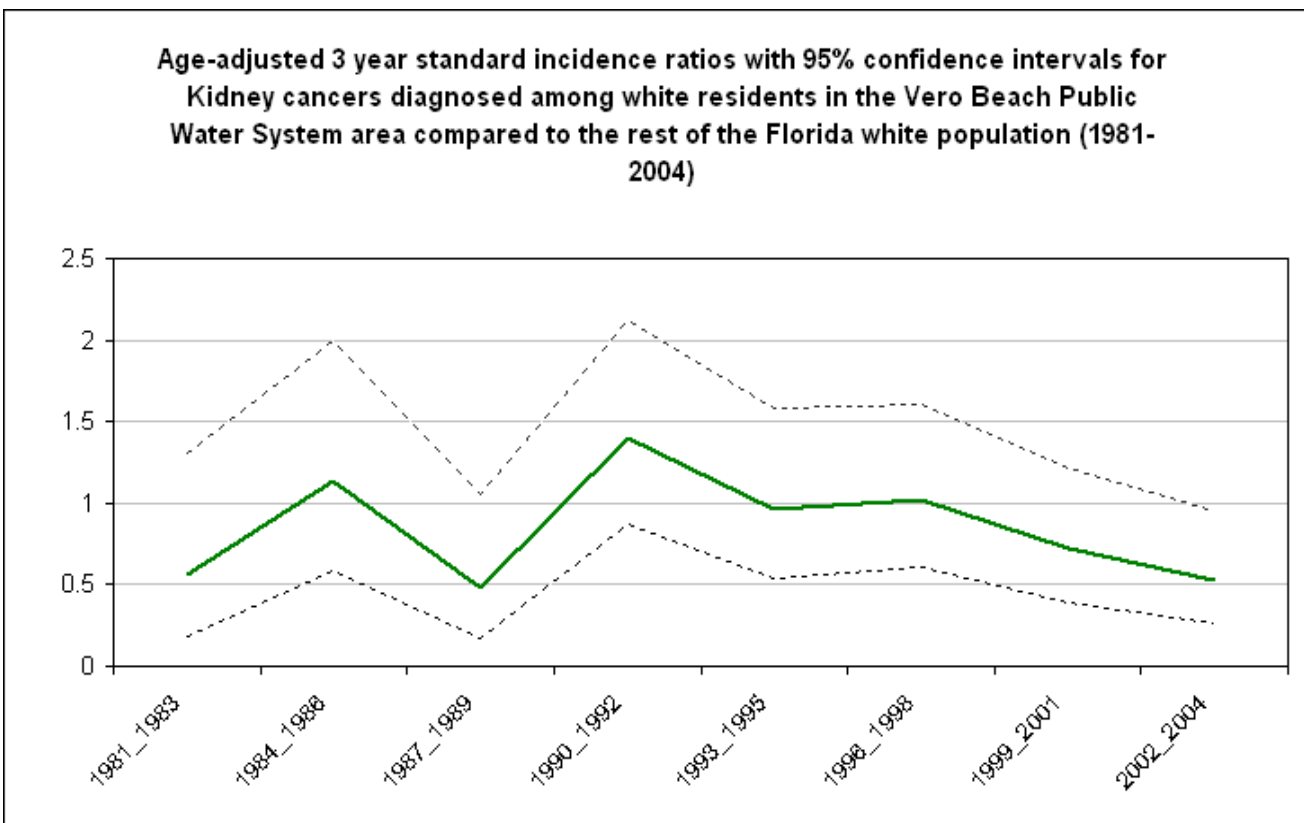


Table 6 and Graph 4: Age-adjusted 3 year SIRs with 95% CL for Non Hodgkin’s lymphoma in white residents of Vero Beach Public Water System area compared to state of FL whites (Years and rates with minor elevations highlighted in yellow)

| Cancer Type | Year(s) | Observed | Expected | SIR | Lower 95% CL | Upper 95% CL |
|-------------|-----------|----------|----------|------|--------------|--------------|
| NHLymphoma | 1981_1983 | 3 | 12.5 | 0.24 | 0.05 | 0.70 |
| | 1984_1986 | 12 | 14.95 | 0.8 | 0.41 | 1.40 |
| | 1987_1989 | 12 | 18.46 | 0.65 | 0.34 | 1.14 |
| | 1990_1992 | 30 | 23.23 | 1.29 | 0.87 | 1.84 |
| | 1993_1995 | 29 | 25.44 | 1.14 | 0.76 | 1.64 |
| | 1996_1998 | 25 | 29.04 | 0.86 | 0.56 | 1.27 |
| | 1999_2001 | 31 | 29.62 | 1.05 | 0.71 | 1.49 |
| | 2002_2004 | 25 | 28.28 | 0.88 | 0.57 | 1.30 |

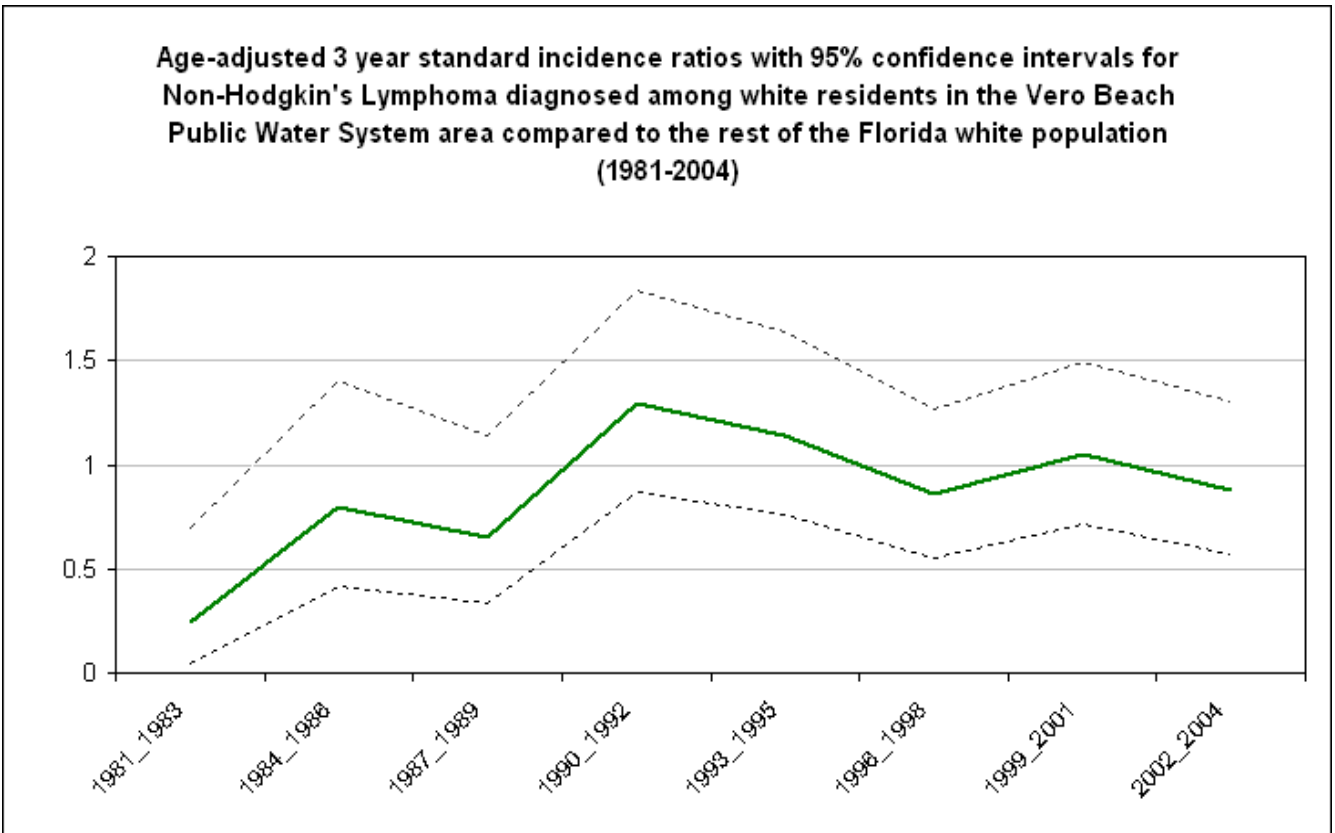


Table 7 and Graph 5: Age-adjusted 3 year rolling SIRs with 95% CL for Leukemias in white residents of Vero Beach Public Water System area compared to state of FL whites (Years and rates with slight elevations highlighted in yellow)

| Cancer Type | Year(s) | Observed | Expected | SIR | Lower 95% CL | Upper 95% CL |
|-------------|-----------|----------|----------|------|--------------|--------------|
| Leukemia | 1981_1983 | 4 | 9.52 | 0.42 | 0.11 | 1.08 |
| | 1984_1986 | 9 | 10.66 | 0.84 | 0.38 | 1.6 |
| | 1987_1989 | 11 | 12.68 | 0.87 | 0.43 | 1.55 |
| | 1990_1992 | 11 | 16.19 | 0.68 | 0.34 | 1.22 |
| | 1993_1995 | 29 | 17.17 | 1.69 | 1.13 | 2.43 |
| | 1996_1998 | 19 | 18.74 | 1.01 | 0.61 | 1.58 |
| | 1999_2001 | 20 | 20.58 | 0.97 | 0.59 | 1.5 |
| | 2002_2004 | 28 | 17.8 | 1.57 | 1.04 | 2.27 |

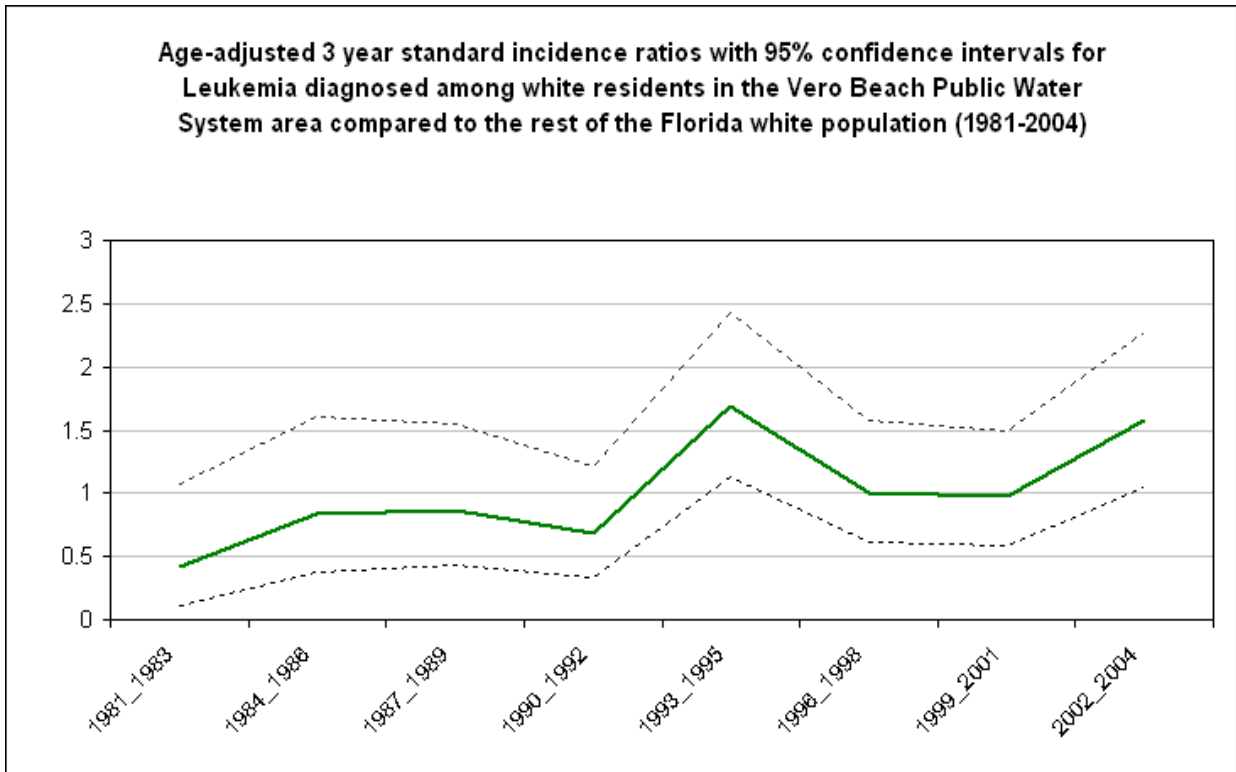
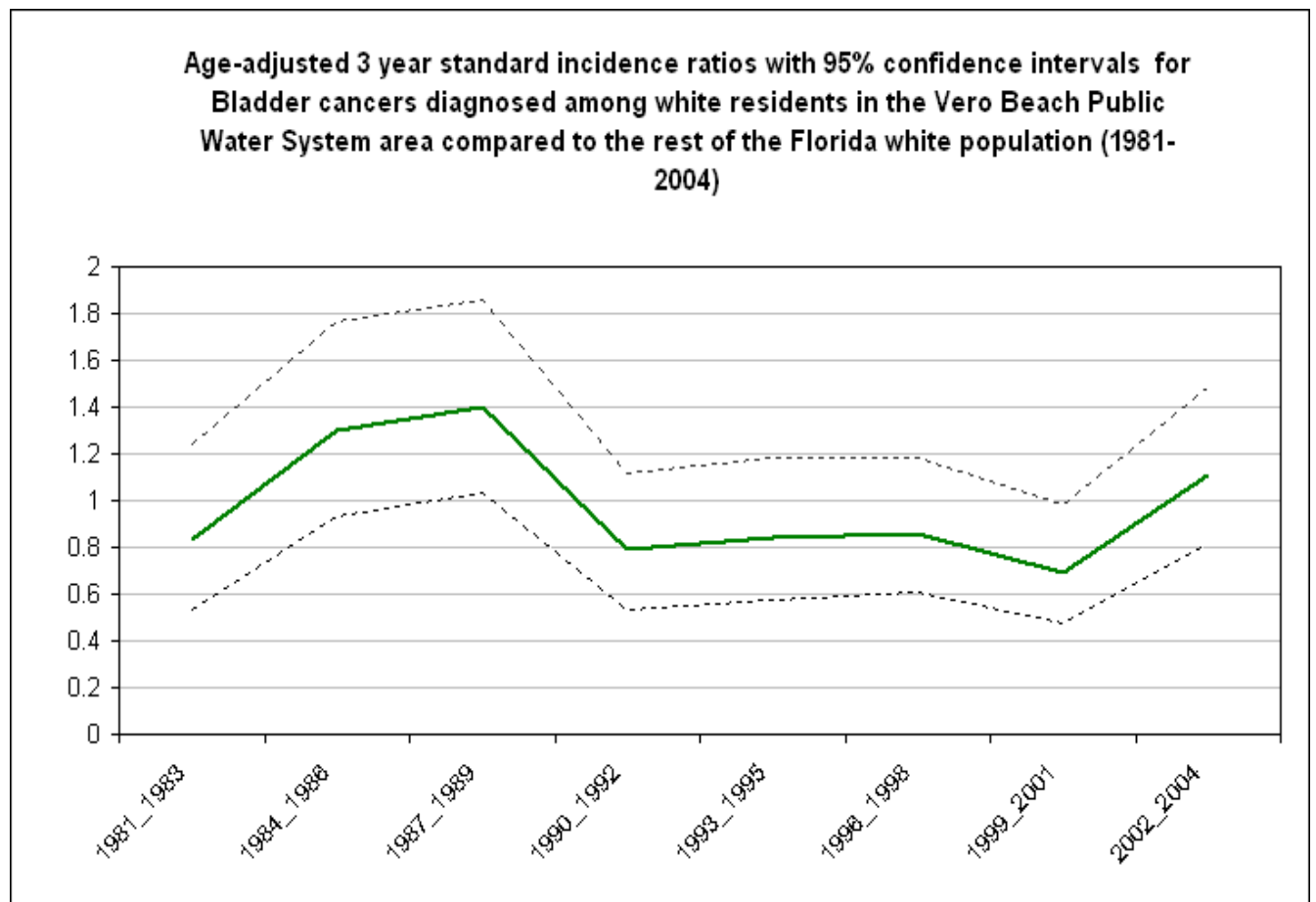


Table 8 and Graph 6: Age-adjusted 3 year SIRs with 95% CL for Bladder Cancer in white residents of Vero Beach Public Water System area compared to state of Florida white (Years and rates with slight elevations highlighted in yellow)

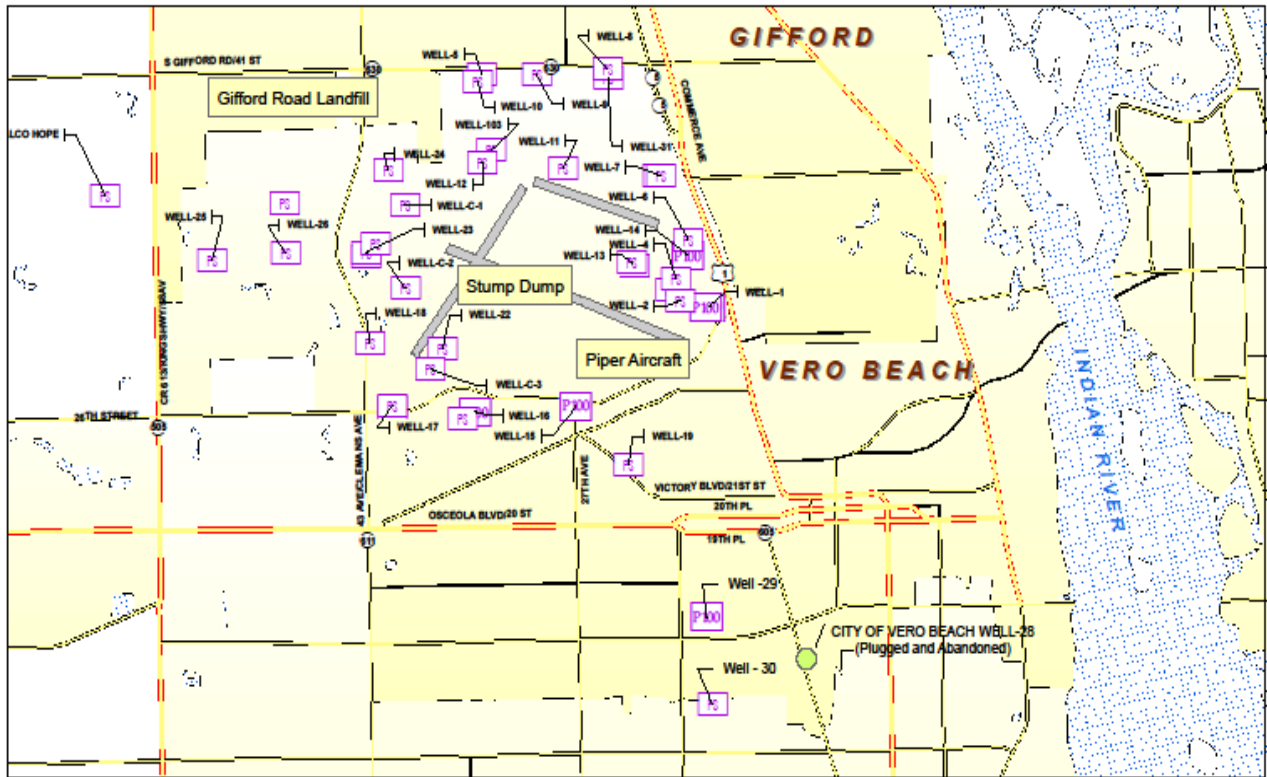
| Cancer Type | Year(s) | Observed | Expected | SIR | Lower 95% CL | Upper 95% CL |
|-------------|-----------|----------|----------|------|--------------|--------------|
| Bladder | 1981_1983 | 24 | 28.87 | 0.83 | 0.53 | 1.24 |
| | 1984_1986 | 41 | 31.43 | 1.3 | 0.93 | 1.77 |
| | 1987_1989 | 48 | 34.19 | 1.4 | 1.03 | 1.86 |
| | 1990_1992 | 30 | 38.08 | 0.79 | 0.53 | 1.12 |
| | 1993_1995 | 33 | 39.37 | 0.84 | 0.58 | 1.18 |
| | 1996_1998 | 38 | 44.24 | 0.86 | 0.61 | 1.18 |
| | 1999_2001 | 32 | 46.21 | 0.69 | 0.47 | 0.98 |
| | 2002_2004 | 48 | 43.11 | 1.11 | 0.82 | 1.48 |





Florida Department of Health
Bureau of Water Programs
Well Surveillance Tracking System

WELL SURVEILLANCE AREA: 09040
COUNTY: 31 STATUS: ACTIVE
ANALYSIS: SOLVENTS
PROJECT: TOXICS

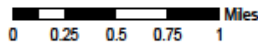


Legend

PWS Wells (DOH Data)

LG PWS

- P5 PWS < 100,000 gpd
- P100 PWS > 100,000 gpd
- P7 Unspecified



**CITY OF VERO BEACH MUNICIPAL WELL FIELD
INDIAN RIVER COUNTY, FLORIDA**

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3/19/2010
GordonLA

Map 1. City of Vero Beach Municipal Water Well Field with Piper Aircraft, Stump Dump and Gifford Road Landfill Sites Identified



Map 2. City of Vero Beach area served by Municipal Water Supply Including City of Vero Beach, South Beach and Indian River Shores