

# **Analysis of Cancer Incidence Data in Coldwater Creek Area, Missouri, 1996-2004**

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## **Executive Summary**

One of the top priorities of the Missouri Department of Health and Senior Services (DHSS) is to ensure Missourians are healthy, safe and informed. When individuals and communities have personal and difficult health concerns they often seek our assistance to find answers. We take this responsibility very seriously. To accomplish this, DHSS translates data and evidence-based practices into practical information to help individuals understand and take appropriate action on issues of public health.

Regarding cancer concerns, DHSS uses a systematic, multi-disciplinary approach to gather and evaluate data, draw scientifically sound conclusions and provide recommendations that promote and protect public health. As part of ongoing surveillance and in response to community concerns, DHSS has completed a review of cancer incidence in the area around Coldwater Creek.

Coldwater Creek is adjacent to several sites in the St. Louis, MO, area which were involved in the processing and recovery of uranium during World War II. These sites were contaminated with radioactive waste as a result of those activities. Several other federal and state agencies are involved in ongoing environmental cleanup actions at these sites. DHSS will remain in a public health oversight role for ongoing environmental actions at these sites to assess public health concerns. While most of the radioactive wastes have been cleaned up, citizens have expressed concern that exposure to the wastes has increased the number of cancer cases in the area.

DHSS's efforts of monitoring the incidence and mortality of cancers in the Coldwater Creek area extend back at least 25 years. In this current analysis, the observed numbers of incident cases for 27 types of cancer and all cancers combined in the Coldwater Creek area were compared to the expected numbers of cases based on the incidence rates for the State of Missouri during 1996-2004. These numerous types of cancer were evaluated in an effort to be as complete as possible.

Authoritative cancer epidemiology research associates leukemia and thyroid cancers to specific environmental sources of radiation. Our current analysis, however, found that leukemia incidence is not significantly higher, and thyroid cancer incidence is significantly lower than expected. Taken together, these results indicate that an increased cancer risk in the population due to environmental radiation exposure is unlikely.

Several types of cancer were found at significantly higher incidence rates than expected, including female breast, colon, prostate and kidney. Other cancers showed results lower than expected. While female breast cancer can be associated with radiation, there is minimal evidence for low to moderate level environmental radiation exposure as a risk factor share. The cancer rates that are elevated do share several common risk factors, such as smoking, physical inactivity, unhealthy diets, and diabetes. Some of these risk factors may help explain those findings.

As a result of this analysis, the DHSS cancer inquiry committee recommends the state and local public health agencies increase cancer prevention and health promotion efforts in the area. Efforts should be targeted to promote healthy eating, regular physical activity and tobacco control. These actions are expected to have the greatest positive impact on cancer prevention in the community.

No matter what the cause or concern in the area, DHSS remains dedicated to addressing the public health concerns of community members.

**A note regarding cancer cluster concerns and the environment:**

It is not uncommon for individuals or communities to become concerned about a perceived excess of cancer or other chronic disease. These concerns are often reported to state and local health agencies with an expectation that a causal link to a common identifiable risk factor will be found. While conclusive findings are rare in any cluster investigation, DHSS uses a systematic, multi-disciplinary approach, consistent with national guidelines, to determine if a perceived excess is real. As important to the scientific cancer inquiry process is the opportunity to provide critical health information to the individuals and communities we serve.

- Cancer is not one disease. Different cancers, like other chronic diseases, have different causes and risk factors.
- Cancer is very common. More than 1 in 3 women and nearly 1 in 2 men will be affected by some type of cancer in their lifetime.
- Age, family history (genetics) and lifestyle factors (diet, exercise, alcohol or tobacco use) are usually more important risk factors for cancer than environmental contamination.
- Clustering can still be a random occurrence, even when statistical tests indicate that cancer cases are higher than expected.

## **Site History**

The Formerly Utilized Sites Remedial Action Program (FUSRAP) is an environmental remediation program established by the U.S. government. The purpose of the program is to address radiological contamination from activities by the Manhattan Engineering District and Atomic Energy Commission during atomic bomb development in the 1940s through 1960s. As a part of these projects, the Mallinckrodt facility in downtown St. Louis was contracted by the U.S. government to extract uranium from ore so it could be sent to other facilities. The extracted uranium was then sent to other facilities for enrichment, such as Oak Ridge National Laboratory in Tennessee. The site in downtown St. Louis operated from 1942-1957.

During the course of the operations, waste materials were stockpiled at a site in North St. Louis County located close to Lambert International Airport. This site became known as the St. Louis Airport Site (SLAPS). In the 1960s and 1970s, some of the waste material (which could potentially have been recycled) was sold by the AEC to a private company, which transported the material to another location north of the SLAPS. This site became known as the Hazelwood Interim Storage Site (HISS). The North County FUSRAP site consists of the SLAPS, HISS and 78 vicinity properties (known as SLAPS VPs). The U.S. Department of Energy (DOE) was responsible for the remediation of the FUSRAP sites from the late 1970s until 1998 when the federal government transferred authority to the U.S. Army Corps of Engineers (USACE).

Coldwater Creek from Banshee Road to its confluence at the Missouri River is a SLAPS Vicinity property. The creek has been affected by runoff from the FUSRAP sites in North St. Louis County. Coldwater Creek passes through several north St. Louis County communities including Florissant, Hazelwood, Black Jack and Spanish Lake. Several communities and citizens have raised concerns related to the FUSRAP contamination and Coldwater Creek.

Historically, the DOE collected some sediment and soil samples along Coldwater Creek from Banshee Road to the Missouri River. The USACE has collected and analyzed surface water and sediment samples. In 1994, the Agency for Toxic Substances and Disease Registry (ATSDR) evaluated historical soil and sediment data from Coldwater Creek. Based on the information available at the time, they were unable to establish that a public health risk existed. Since that time, the USACE has undertaken two clean up actions at Coldwater Creek and a clean up of soils at St. Denis Bridge. During 2012 and 2013, the USACE is collecting sediment and soil samples in the creek from McDonnell Boulevard to Byassee/Frost Avenue. When available, this data along with other recent data collected since the USACE clean up actions, will be evaluated for any public health concerns by the DHSS Bureau of Environmental Epidemiology.

## **Human Exposure Pathways**

The risks posed by exposure to an environmental contaminant depend on a number of factors, including the concentration of the contaminant, the frequency of exposure, the duration of exposures and the route of exposure. The Coldwater Creek site contains soil and sediment primarily contaminated with radioactive radium, thorium, and uranium. Although the 1989 Public Health Assessment by ATSDR concluded that there was no known use of the creek for recreation, several current and former residents have more recently stated that recreational use of the creek was and is occurring. External exposure to ionizing radiation from the contaminated soils and sediments in the creek is unlikely to be of concern because of the type of radiation present and the relatively small amount of time a member of the public would spend there. Internal inhalation or, more likely, incidental ingestion of contaminated sediments from around the creek during recreation has more potential for exposure. This could occur by an individual getting contaminated sediment on his or her hands and then placing their hands in or near their mouth before washing them, such as to eat, drink or smoke a cigarette. Coldwater Creek is not used as a drinking water source, so this is not considered a significant route of potential exposure; furthermore, federal drinking water standards for radiation are not exceeded in the Coldwater Creek.

## **Missouri Department of Health and Senior Services (DHSS)'s Efforts of Monitoring the Incidence and Mortality of Cancers in the Coldwater Creek Area**

In response to the local citizens' concerns, the DHSS (former Missouri Department of Health [MDOH]) conducted several studies of the incidence and mortality of leukemia, colon, prostate, breast, lymphoma, melanoma and thyroid cancers in the region. The findings of these studies are summarized as follows:

### **MDOH Activities**

In 1988, MDOH examined mortality and incidence data for five sites in the St. Louis area: HISS, SLAPS, SLDS, Westlake Landfill and the Combustion Engineering plant at Hematite, by census tract for the first four sites and by zip code for the remaining site. Data were obtained from death certificates submitted to the State Center for Health Statistics and included all persons residing in the particular census tract or zip code with a cause of death attributed to any type of cancer during 1979-1987. Incidence data were obtained from the Missouri Cancer Registry (MCR) and included all new cases of cancer reported to MCR between August 1984 and September 1988. Observed and expected deaths were calculated for four age groups and total deaths, by sex. Based on the absence of statistically significant excesses of radiation-associated cancers in the death data and only one potentially suspicious case from the census tract, there appeared to be little evidence for an excess of cancer. Observed versus expected incident cases could not be calculated since the MCR was not yet population-based.

### **HISS/Latty Avenue/Nyflot**

In January 1989, the MDOH's Cancer Inquiry Committee (CIC) contacted the residents of Nyflot Avenue in response to their concerns regarding four cases of leukemia and two other cancers (colon and prostate) in one individual. The residents confirmed the cancer cases reported by the initiator of the inquiry and reported two additional cases. These findings, coupled with knowledge that radioactive contamination existed at three sites: SLAPS, HISS, Futura Coatings Company (FUTURA), as well as along roads formerly used to transport radioactive materials, led MDOH's CIC to recommend expanding the inquiry in February, 1989.

The CIC further interviewed present and past residents, examined medical records and constructed a chronology of deposition of radioactive materials and of diagnosis dates and times of residence of the cancer patients. The result of the interviews and examination of medical records confirmed the existence of the eight cases of cancer found in the preliminary review, plus identified and confirmed two additional cases among past and present residents of the block. The diagnosis dates of these 10 cancer cases ranged from 1963 to 1989, with six of the cancers being diagnosed in the 1980's. Because of the small number of people studied and lack of complete information (total number of residents during the time period studied, their ages, and how long they lived in the area), it was not possible to determine whether the observed number of cases was significantly different from that expected.

### **Objectives of the Current Study:**

The objectives of the current study were to continue the DHSS's efforts of monitoring cancers in this area and responding to local citizens' concerns about the number of people with cancer in the Coldwater Creek area according to the Missouri Cancer Inquiry Protocol.

### **Study Method:**

For this study, the area selected for analysis included the ZIP codes adjacent to the Coldwater Creek: 63031, 63033, 63034, 63042, 63134 and 63138 (the combination of ZIP codes is referred to as the designated area, see Figure 1). The observed number of cancer cases from each ZIP code and the designated area were compared with the expected number based on the incidence rates for the State of Missouri for the period of 1996 through 2004. The analysis was completed using data based on the ZIP code where people were living at the time of diagnosis. Information about the residential history of where patients lived prior to their diagnosis was not available.

When calculating the expected number of cases, the age-, gender-, and race- specific incidence rates for the selected cancers in the State of Missouri were applied to the study population of the corresponding demographic groups to obtain an expected number of cases for the study area (i.e., using the indirect method of rate standardization). Standardized incidence ratios (SIRs), the ratios of the observed to expected numbers of incident cancers, were calculated. Ninety-five percent confidence intervals (CIs) for the SIRs were computed by assuming the observed number to be distributed as a Poisson variable<sup>1</sup>. A 95% CI that contains 1.0 means that the observed number of cancers was not significantly different from that expected. Conversely, a 95% CI that does not include 1.0 indicates that the observed number of cases was statistically significantly different, either higher or lower, from the expected number. For the purposes of this report, those numbers will be denoted as “significantly higher” or “significantly lower” than expected.

The stage of diagnosis of female breast, prostate, colorectal, and kidney and renal pelvis cancers in the designated area was compared to that for the State of Missouri. The prevalence of some behavioral risk factors was calculated for the designated area and the State of Missouri using the 2011 county-level study. However, since the sample size for the designated area was small, it was not possible to weight the data to reflect the socio-demographic characteristics of the population in the area. Therefore, the data may not be representative of the population in the area. Also these data are from a survey conducted in 2011, so they do not necessarily reflect risk factor levels 10 or more years before the cancers were diagnosed. However, even though we know these data are not ideal, they are the only risk behavior data we have for the area.

The DHSS Office of Epidemiology and the Missouri Cancer Registry and Research Center at the University of Missouri-Columbia performed the recent analysis to determine if the observed number of cancer cases was higher than expected for each ZIP code and the designated area based on the rates in the State of Missouri.

### **Results:**

Table 1 shows the socio-demographic characteristics of the populations in the designated area based on the 2010 census data. Age and gender compositions in the area are similar to that in the state. There are a higher proportion of African Americans in all ZIP codes, except for ZIP code 63031, which is similar to the state. However, this will not affect the comparisons between observed and expected cancer cases because age, gender and race have been adjusted in the analysis. The proportion of people with less than a high school education or below poverty was higher in ZIP code 63134, lower in ZIP codes 63031, 63033, 63034 and 63042 than in the state. The proportion in ZIP code 63138 is similar to that in the state. Overall, the designated area has a lower proportion of people with less than a high school education or below poverty than the state. Education and poverty were not adjusted in the analysis because individual cancer patient’s education and income data are not collected by the cancer registry. Because women with a higher socio-economic status have a higher risk of breast cancer, we expect a relatively higher incidence of breast cancer in the area than in the state<sup>2-7</sup>.

Tables 2-8 show the observed and expected cancer cases in each ZIP code and the designated area.

Table 9 summarizes the findings in tables 2-8 and listed the cancers according to their association with ionizing radiation based on the scientific literature<sup>8</sup>. During 1996-2004, a total of 7,772 incident cases of cancer were reported to MCR from the area, with lung/bronchus/trachea/pleura (1,306), female breast (1,197), prostate (1,196), colon (776), and urinary bladder (332) cancers as the top five types of cancer in the designated area, which are the same as the state. The total number of observed all-cancer cases was significantly higher in ZIP codes 63042, 63134, 63138, and the designated area than that expected based on the state rates. Overall cancer elevation in the designated area over that expected based on the state rates was 5.5%.

For cancers that are frequently associated with ionizing radiation with authoritative risk estimates in scientific studies, the analysis found that the observed number of leukemia cases was not significantly different from expected in each ZIP code and the designated area. The number of incident cases of thyroid cancer was actually significantly lower than expected in ZIP code 63033 and the designated area as a whole, but was not statistically

different between observed and expected cases in other ZIP codes. However, the number of female breast cancer cases in the designated area was significantly higher than expected (Table 9).

For cancers that are occasionally associated with ionizing radiation with valid risk estimates in scientific studies, the analysis found a significantly higher number of lung and bronchus cancer in ZIP codes 63042 and 63134; but a significantly lower number of lung and bronchus cancer in ZIP code 63033 and 63034; a significantly higher number of colon cancer cases in ZIP codes 63033, 63138, and the designated area; and a significantly higher number of multiple myeloma cases in ZIP code 63034, compared to the expected number based on the state rates. The observed numbers of stomach, esophageal, bladder, and ovarian cancer cases were not significantly different from that expected for each ZIP code and the designated area (Table 9).

For cancers that are rarely or never associated with ionizing radiation, the analysis found a significantly higher number of kidney and renal pelvis cancer cases in ZIP code 63033 and the designated area; a significantly higher number of rectum/anus/rectosigmoid cancer cases and larynx cancer cases in ZIP code 63134; and a significantly higher number prostate cancer cases in ZIP codes 63031, 63033, 63034, and the designated area. However, a significantly lower number of cervical cancer cases were observed in ZIP codes 63033, 63138, and the designated area, and a significantly lower number of oral cavity and pharyngeal cancer cases were also observed in ZIP code 63034 and the designated area (Table 9). In addition, the observed number of other rare cancers (combined) that were not listed in the data tables (2-8) was significantly lower in ZIP code 63034 (Table 4).

Table 10 shows the stage of diagnosis of female breast, prostate, colorectal, and kidney and renal pelvis cancers in the designated area and in the state. The stage of diagnosis of female breast, colorectal, and kidney and renal pelvis cancers in the area was similar to that in the state. However, a higher proportion of prostate cancer was diagnosed at an earlier stage in the area than in the state. This is perhaps an indication of increased screening and might be a contributing factor to a higher number of incident cases of prostate cancer.

Table 11 lists modifiable risk factors for female breast, prostate, colorectal, and kidney cancers<sup>9, 10</sup>. These cancers share common risk factors—unhealthy diets, lack of physical activity, and overweight/obesity. Table 12 shows the prevalence of some risk factors in the designated area and the state. The prevalence of these risk factors (e.g., smoking, physical inactivity) in the area is similar to that in the state, except for lack of breast cancer screening and lack of cervical cancer screening. The prevalence of no Pap smear test in the last 3 years among women age 18 or older was significantly lower in the area than in the state. If this has been consistent over years, it can at least partially explain why the area has a lower incidence of cervical cancer, because the Pap test is also a prevention measure. The prevalence of no mammogram or clinical breast exam in the area is also lower than the state, although it is only marginally significant because of a small sample size. Again the data in table 12 should be interpreted with caution because these data may not be representative of the population in the area.

### **Discussion:**

The MCR data for the period 1996-2004 have more than a 95 percent completion rate and MCR has received gold certificates from the North American Association of Central Cancer Registries (NAACCR). Therefore, the quality of cancer data used in this study is high. However, the possibility of a biased comparison in the incidence of cancers between the designated area and the State of Missouri cannot be completely ruled out. For example, hospitals in the designated area might have a higher cancer-reporting rate than other parts of the State due to a higher awareness. If this is the case, it is expected that there is a greater likelihood of finding a significantly higher cancer incidence in the designated area than in the state when actually there is no difference. In the case of thyroid cancer, the observed number was below the expected, and this is less likely to be explained by under reporting.

The thyroid gland and bone marrow are particularly sensitive to radiation. Leukemia, a type of cancer that arises in the bone marrow, is the most common radiation-induced cancer. The types of cancer linked to radiation are also affected by the part of the body that is exposed. For example, people who get pelvic radiation therapy would not be expected to have higher rates of cancers in the head and neck because these areas weren't exposed to radiation (11). In this study, we found the number of incident cases of leukemia in the area was not significantly different from expected during 1996-2004; however, the number of thyroid cancer cases was significantly lower than expected. This shows that if environmental radiation exposure occurred among the residents in the area, exposure was below a level of public health concern.

Radiation is a moderate risk factor for breast cancer but minimal data is available associating female breast cancer with low to moderate level environmental radiation exposure. It was linked to breast cancer among Japanese atomic bomb survivors due to mixed gamma and neutron radiation, and among young women who received radiation therapy to the chest, especially during puberty<sup>8</sup>. There are many modifiable and non-modifiable risk factors for breast cancer, including age, race/ethnicity, family history and genetics, certain benign breast conditions, exposure to external hormones, never having children, first full-term pregnancy after age 30, drinking alcoholic beverages, lack of physical activity, overweight/obesity, and unhealthy diets. Unhealthy diet, lack of physical activity, and overweight/obesity are risk factors also shared by prostate, colorectal, and kidney and renal pelvis cancers, for which the area also has higher than expected numbers.

Cigarette smoking is the primary risk factor for the development of lung cancer with about 80 to 90 percent of all lung cancers attributable to smoking. The risk of lung cancer increases with the number of cigarettes smoked (i.e., quantity) and the time over which smoking has occurred (i.e., duration). The risk of developing lung cancer decreases each year following smoking cessation as normal cells grow and replace damaged cells in the lung. In addition, tobacco use is a risk factor for kidney and colon cancers and it likely increases the risk of breast cancer and aggressive form of prostate cancer. The number of lung cancer cases was lower in two ZIP codes and higher in another two ZIP codes, and overall, it is not higher in the area. The inconsistencies in the findings of this study suggest the reason for the higher lung cancer incidence in certain ZIP codes might be due to smoking.

There are many risk factors for colon cancer, including older age, being African-American or Ashkenazi Jew, history of colorectal polyp and inflammatory bowel disease, family history, inherited syndromes, type 2 diabetes, unhealthy diet, physical inactivity, obesity/overweight, smoking, heavy alcohol use, and lack of screening among those age 50 or older. Ionizing radiation was found to be linked with colon cancer among Japanese atomic bomb survivors and among women who received a cumulative total of up to 5-10 Gy x-ray treatments in the pelvic area. No associations were found in other studies conducted among nuclear workers, radiologists, or other medical treatments<sup>8</sup>.

While the exact cause of multiple myeloma is not known, the factors that increase the risk of developing multiple myeloma are primarily non-modifiable and include: age (generally 65 and older), African-American, men having slightly higher incidence than women, family history of multiple myeloma and genetic precursor conditions. Exposure to radiation is suspected to increase the risk of multiple myeloma among Japanese atomic bomb survivors, nuclear workers, radiologists, nuclear test participants, etc; however, the association has not been confirmed<sup>8</sup>.

A limitation of this study is that, since there was no inter-census population data available at the U.S. Postal Service ZIP code level, the 2000 Census ZIP Code tabulation areas (ZCTA) populations were used to estimate the population for the ZIP codes and the designated area during 1996-2004. In doing so, an assumption was made that the population changes in the ZIP code and the designated area during 1996-2004 were similar to that of the State of Missouri. To make the number of years before and after the year 2000 the same, we chose the study period of 1996-2004 to reduce bias. Another limitation of this study is that it is a surveillance-based study, which estimates the overall risk for the population in each ZIP code and the designated area. Individuals in the

area may have large variations in both exposure dose and duration. However, the dose and duration data are not available in the cancer registry database and cannot be taken into account in this analysis.

Before drawing conclusions from these data, three aspects of the statistical method need to be considered. First, random fluctuations in the disease occurrence cannot be completely ruled out in explaining differences between observed and expected numbers, even when the difference is statistically significant. The problem of random fluctuation is expected to be more prominent as the study areas become smaller. The second aspect is the power of the statistical test; that is, the probability that a true departure from the expected number can be detected by significance testing. A non-significant difference sometimes reflects low statistical power rather than the absence of differences. In this study, the power of detecting a difference was higher for the designated area than for each individual ZIP code. Third, when making so many comparisons, the play of chance might contribute to the observed findings; e.g., if 100 comparisons are made, 5 might be expected to be significantly high or low based on chance alone.

### **Conclusions and Recommendations:**

In the Coldwater Creek designated area during 1996-2004, the number of incident cases of leukemia was not statistically significantly higher, and the number of incident cases of thyroid cancer was statistically significantly lower than that expected based on the state rates, indicating a greater cancer risk from radiation is unlikely. The number of female breast cancer cases was statistically significantly higher than expected, so was the number of colon, prostate and kidney cancers in the area. These cancers share common risk factors including unhealthy diets, lack of physical activity, obesity, smoking, and diabetes. The DHSS cancer inquiry committee recommends the state and local public health agencies increase cancer prevention and health promotion efforts in the area by promoting healthy eating, regular physical activity, and tobacco control. DHSS will also continue as appropriate to assess available environmental data to assure public health protective cleanup actions at Coldwater Creek and the adjacent sites.

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