Executive Summary
Supplement Evaluation of Thyroid and All Rare
Cancer Ratios in Ten Areas around Rocky Flats,
Colorado Compared to the Remainder of Metropolitan
Denver, 1990-2014

CDPHE | COLORADO
Department of Public
Health & Environment

Background

- In 2016, the Colorado Central Cancer Registry (CCCR) at the Colorado Department of Public Health and Environment (CDPHE) prepared a report evaluating 1990-2014 cancer incidence for a fairly large geographic area surrounding the Rocky Flats site. That evaluation included cancer of the esophagus, stomach, colon and rectum, liver, lung, prostate, bone, leukemias, lymphomas, and brain and central nervous system.
- The CCCR and Environmental Epidemiology Division of CDPHE have prepared a supplement to the 2016 report in response to public requests and a request from the CDPHE Hazardous Materials and Waste Management Division to evaluate claims of higher than expected frequencies of thyroid cancer and "rare" cancers in the vicinity of Rocky Flats.
- This supplement uses data from the CCCR, which registers all cancers diagnosed in Colorado residents, to evaluate the incidence of thyroid and "rare" cancers and uses the same methods as the 2016 report.
- The report compares the incidence of thyroid cancer and all "rare" cancers in ten communities or Regional Statistical Areas (RSA) - which were selected for their proximity to Rocky Flats - to the incidence of cancer expected based on rates in the remainder of the Denver Metro area. (See Figure 1)
- These types of evaluations have been conducted frequently around communities adjacent to suspected environmental exposures since they are efficient, cost effective, and can be completed within a reasonable period of time.
- The intent of this report is to give Colorado's citizens a way to compare their community's thyroid and "rare" cancer incidence to the remainder of the Metro Denver area during the 1990-2014 time period.

Overall Findings

- There was no evidence of higher than expected frequencies of thyroid cancer in the vicinity of Rocky Flats. Thyroid cancer was not higher than expected for the entire 10-RSA area combined and for the ten individual RSA regions for males or females.
- For the entire 10-RSA region combined, the incidence of "rare" cancers was not higher than expected for either males or females compared to the remainder of the Denver Metro area.
- Nine of the ten RSA regions for each gender had incidence of "rare" cancers that was not higher than expected compared to the remainder of the Denver Metro area.
- One of the ten RSA regions, RSA 205, "Wheat Ridge", had a statistically higher than expected count of "rare" cancers for one gender, males, a finding explained by higher rates of male, pancreatic cancer. Pancreas cancer has many risk factors associated with it, among which are smoking, heavy alcohol use, being overweight or obese,

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family history of the disease, and diabetes. Over 2/3 of male pancreas cancer cases in this area had a history of smoking and some evidence of alcohol use was also documented.

- For more information on the Rocky Flats site and Rocky Flats cancer studies, please visit the CDPHE Rocky Flats webpage, available at: https://www.colorado.gov/pacific/cdphe/rocky-flats.

Cancer Risk Factors and Prevention

- Cancer is not a single disease, but a group of over 100 different diseases that share some common characteristics. Cancer is common; it is the second leading cause of death in the United States. Three of every five cancer deaths are due to tobacco use, being overweight, lack of physical activity, and poor nutrition.
- CDPHE recommends people adopt a healthy lifestyle that includes avoiding tobacco use, avoiding excessive alcohol consumption, and limiting sun exposure. Increasing physical activity, maintaining a recommended body weight, eating a healthful and nutritious diet, and taking advantage of cancer screening will also reduce your risk.
- For more information about tobacco and cancer or quitting smoking, call 1-800-QUIT-NOW or visit https://www.coquitline.org

About the Colorado Central Cancer Registry

- Monitoring of cancer incidence in Colorado is performed by the Colorado Central Cancer Registry (CCCR) at Colorado Department of Public Health and Environment (CDPHE).
- All cancers diagnosed in Colorado residents are reported to the CCCR with the exception of non-melanoma skin cancers.
- All Colorado hospitals, pathology labs, and outpatient clinics submit medically-confirmed cancer data to the CCCR. The registry is mandated by Colorado law [C.R.S. 25-1-107 (1) (z)] and by Colorado Board of Health regulation [6 CCR 1009-3].
- All individual patient, physician, and hospital information is confidential as required by Colorado law [C.R.S. 25-1-122 (4)].
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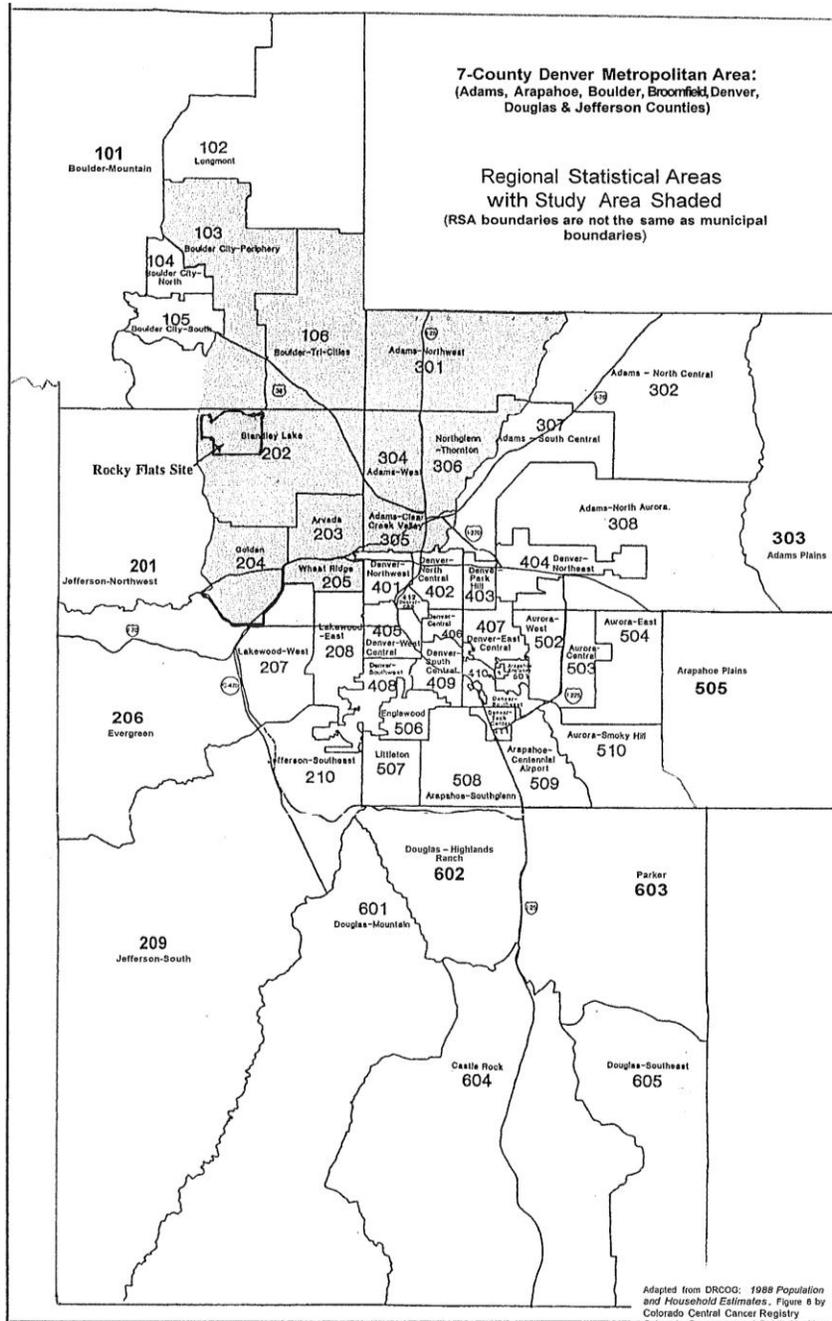Denver, 1990-2014

Figure 1 – Study areas shaded in gray and comparison population (remainder of metro area)

Supplement evaluating thyroid cancer and all rare cancers

Ratios of Cancer Incidence in
Ten Areas around Rocky Flats, Colorado
Compared to the
Remainder of Metropolitan Denver, 1990-2014

Prepared by:

Colorado Central Cancer Registry
Center for Health and Environmental Data (CHED)

In collaboration with:

Environmental Epidemiology, Occupational Health, and Toxicology
Disease Control and Environmental Epidemiology Division

2017

Executive Summary

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of the disease, and diabetes. Over 2/3 of male pancreas cancer cases in this area had a history of smoking and some evidence of alcohol use was also documented.
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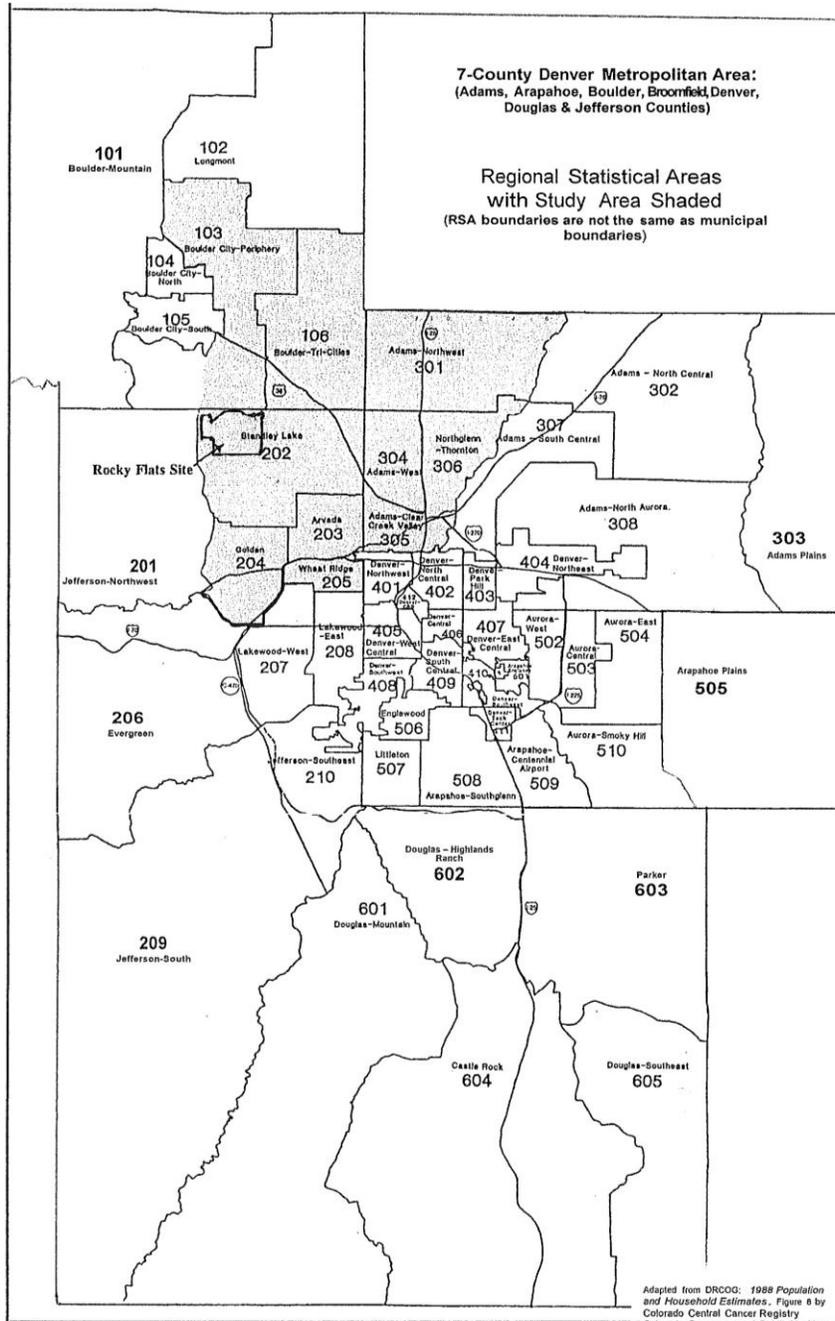- For other Colorado cancer statistics or more information on the CCCR, please visit: https://www.colorado.gov/pacific/cdphe/cancerregistry

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Supplement evaluating thyroid cancer and all rare cancers

In response to public requests and a request from the CDPHE Hazardous Materials and Waste Management Division to evaluate claims of higher than expected frequencies of thyroid cancer and "rare" cancers in the vicinity of Rocky Flats, the Colorado Central Cancer Registry and Environmental Epidemiology Division of CDPHE have prepared a supplement to the 2016 Rocky Flats cancer incidence report. All analyses were conducted with the same methodology and data sources used in the original report.

Background of CDPHE 2016 Rocky Flats cancer incidence report.

In late 2016, the Colorado Central Cancer Registry (CCCR) at the Colorado Department of Public Health and Environment (CDPHE) prepared a report evaluating 1990-2014 cancer incidence for a fairly large geographic area surrounding the Rocky Flats site. That evaluation included cancer of the esophagus, stomach, colon and rectum, liver, lung, prostate, bone, leukemias, lymphomas, and brain and central nervous system. These specific types of cancer were recommended by the Health Advisory Panel on Rocky Flats as either possibly linked with plutonium exposure or of special concern to panel members.

Background of MSU/Downwinders Health Survey

In the fall of 2016, preliminary results from the Rocky Flats Downwinders Health Survey conducted by Metropolitan State University (MSU) were released. The survey, based on convenience sampling, was designed to collect data from residents who lived in the Denver Metro area between 1952 and 1992 within the boundaries of Highway 128/120th Ave. on the north, I-25 on the east, I-70 on the south and Highway 93 on the west. The survey stated that thyroid cancer and "rare" cancers were seen at a higher prevalence than expected.

The term, "rare" cancer, was taken by the researchers from a paper by Greenlee et. al. [1] where it was defined as any cancer with an incidence rate less than 15 new cases per year/100,000 population. In the Greenlee paper, out of a total of 71 types of cancer, there were 60 types meeting this definition of "rare" and 11 types of cancer considered "common" (prostate, breast, lung, colon, uterine, bladder, rectum, ovary, kidney, melanoma, and nodal non-Hodgkin lymphoma).

At the time, the survey reported 848 cases of cancer reported with 414 (49%) of those cases being "rare". "Rare" cancers made up 49% of all cancers reported in the health survey compared to an expected percentage of about 25% based on U.S. data quoted from the paper. Thyroid cancer was reported to be the second most common cancer found in the survey compared to an expected rank of 9th most common based on U.S. and Colorado data.

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[1] Robert Greenlee, Marc Goodman, Charles Lynch, Charles Platz, Lori Havener, and Holly Howe (2010) The Occurrence of Rare Cancers in U.S. Adults, 1995-2004, *Public Health Reports*, January-February, 125: 28-43.

<u>Limitations of the MSU/Downwinders Health Survey</u>

There are a number of important limitations with the MSU/Downwinders Health Survey design and interpretation:

(1) Convenience sampling is vulnerable to selection bias because the data about cancer is self-reported rather than confirmed through medical records as is done with standard health surveillance systems for cancer data collection that exist in every state. Also not every diagnosed cancer will be self-reported for various reasons, which can lead to the sample not representing the total population. For example, melanoma, a serious form of skin cancer, appears to be under-represented in the survey possibly because it is not on the list of cancers included on the survey website, yet is ranked 3rd among prevalence in the Denver Metro population.

(2) The survey results were not adjusted for the age, gender and race of the respondents or the population of residents in the area, all variables that affect the distribution and frequency of types of cancer that occur. For example, the paper by Greenlee[1] used by the researchers to define "rare" cancers states that "rare cancers occurred with greater relative frequency among those who were younger, nonwhite and of Hispanic ethnicity than among their older, white, non-Hispanic counterparts".

(3) The survey results compared a rank order of cancer <u>prevalence</u> to U.S. and Colorado cancer <u>incidence</u>. These two statistics, prevalence and incidence, describe cancer in different ways and should not be compared directly. Prevalence is a measure of the number of cancer survivors at a point in time or over a given time period, while incidence is a measure of the number of new cancer cases diagnosed in a given time period. Both measures are sensitive to the distribution of age, sex and race in the population at risk of cancer.

(4) Prevalence also depends on how fatal or survivable each type of cancer may be. For example, lung cancer ranks 3rd for incidence behind breast and prostate cancer, but ranks 12th for prevalence because it can kill quickly resulting in very low survival rates. Thyroid cancer incidence ranks 9th, but based on prevalence (survivors) it is 7th, and in persons under age 65, the prevalence rank moves to 3rd because it has high survival rates and is often diagnosed in younger persons. It is three times more common in women than men, as well.

CDPHE Supplemental Analysis of Thyroid and "Rare" Cancers

In late 2016, the Colorado Department of Public Health and Environment released the report, "Ratios of Cancer Incidence in Ten Areas Around Rocky Flats, Colorado Compared to the Remainder of Metropolitan Denver, 1990-2014". All analyses for this supplemental report were conducted with the same methodology and data sources used in the original report (https://www.colorado.gov/pacific/cdphe/cancerregistry):

- o Study geography includes ten Regional Statistical Areas (RSAs) selected for their proximity to Rocky Flats (within 12-16 miles south, southeast, east, northeast and north of the former plant). The ten RSAs are aggregates of a number of smaller U.S. Census areas called census tracts, which contribute population counts from 1990, 2000 and 2010 by race/ethnicity, age and sex.

- o Analysis method compared the number of diagnosed cancers for each sex during 1990-2014 in each RSA to the expected number of cancers based on the cancer rates by race/ethnicity, sex and age of the remainder of the Denver Metro area outside the 10-RSA region. Observed-to-expected ratios of cancer cases were then calculated to see if they were statistically significant.

Thyroid Cancer

Tables 1 and 2 present numbers of thyroid cancer cases diagnosed and expected by sex for 1990-2014 for the ten RSA regions in the vicinity of Rocky Flats. None of the ten RSA areas had statistically higher than expected counts of thyroid cancer for males or females over this time period. Some RSA regions had statistically lower than expected thyroid cancer counts. Also, thyroid cancer was not higher than expected for the entire 10-RSA area combined for males or females compared to the remainder of the Denver Metro area.

Table 1 – Thyroid Cancers Diagnosed in Ten Regional Statistical Areas (RSAs) in the Vicinity of Rocky Flats 1990-2014, Ratios of Observed to Expected Counts of Cancers - Males				
	Cancers Diagnosed	Cancers Expected[1]	Diagnosed/ Expected Ratio	95% C.I. for Ratio
RSA 103 - "Boulder City - Periphery"	18	18.244	0.99	0.58-1.56
RSA 106 - "Boulder – Tri-Cities"	52	53.820	0.97	0.72-1.27
RSA 202 - "Standley Lake"	52	54.847	0.95	0.71-1.24
RSA 203 - "Arvada"	45	50.903	0.88	0.65-1.18
RSA 204 - "Golden"	14	23.363	0.60	0.33-1.01
RSA 205 - "Wheat Ridge"	26	23.354	1.11	0.73-1.63
RSA 301 - "Adams - Northwest"	47	43.842	1.07	0.79-1.43
RSA 304 - "Adams - West"	40	59.092	0.68[*]	0.48-0.92
RSA 305 - "Adams – Clear Creek Valley"	7	23.607	0.30[**]	0.12-0.61
RSA 306 - "Northglenn - Thornton"	34	47.803	0.71[**]	0.49-0.99
Total 10-RSA	335	383.046	0.88	

[1]Expected cancer counts based on cancer rates of the Denver Metro area outside the total 10-RSA area seen on the map in Figure 1.

Note: 95% Confidence Interval means that the Diagnosed/Expected ratio is between the lower and upper values with 95% confidence. Diagnosed/Expected ratios that have a 95% Confidence Interval that include the value 1.00 are not considered statistically high or low. A ratio above 1.00 that is statistically significant means there were more diagnosed cases than expected and that there is less than a 5% chance that this higher number is due to chance alone.

[*] Ratio is statistically significant at p=0.05 level. ([**] p=0.01 level)

Source: Colorado Central Cancer Registry, Colorado Department of Public Health and Environment

Table 2 – Thyroid Cancers Diagnosed in Ten Regional Statistical Areas (RSAs) in the Vicinity of Rocky Flats 1990-2014, Ratios of Observed to Expected Counts of Cancers - Females				
	Cancers Diagnosed	Cancers Expected[1]	Diagnosed/ Expected Ratio	95% C.I. for Ratio
RSA 103 - "Boulder City - Periphery"	45	47.846	0.94	0.69-1.26
RSA 106 - "Boulder – Tri-Cities"	127	157.845	0.81*	0.67-0.96
RSA 202 - "Standley Lake"	139	161.068	0.86	0.73-1.02
RSA 203 - "Arvada"	133	145.655	0.91	0.76-1.08
RSA 204 - "Golden"	49	57.944	0.85	0.62-1.12
RSA 205 - "Wheat Ridge"	59	67.282	0.88	0.67-1.13
RSA 301 - "Adams - Northwest"	118	134.586	0.88	0.73-1.05
RSA 304 - "Adams - West"	128	177.497	0.72**	0.60-0.86
RSA 305 - "Adams – Clear Creek Valley"	44	68.919	0.64**	0.46-0.86
RSA 306 - "Northglenn - Thornton"	119	151.148	0.79**	0.69-0.94
Total 10-RSA	961	1117.415	0.86*	

[1]Expected cancer counts based on cancer rates of the Denver Metro area outside the total 10-RSA area seen on the map in Figure 1.

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* Ratio is statistically significant at p=0.05 level. (** p=0.01 level)

Source: Colorado Central Cancer Registry, Colorado Department of Public Health and Environment

<u>"Rare" Cancers</u>

Tables 3 and 4 present diagnosed and expected counts of all the "rare" cancers defined in the paper by Greenlee et. al.[1] and referenced by the MSU/Downwinder's survey. For the entire 10-RSA region combined, the incidence of "rare" cancers was not higher than expected for either males or females compared to the remainder of the Denver Metro area. Also, nine of the ten RSA regions for each gender had incidence of "rare" cancers that was not higher than expected. One of the ten RSA regions had a statistically higher than expected count of "rare" cancers for one gender, males.   Table 3 shows that RSA 205, "Wheat Ridge", had 734 "rare" male cancer cases compared to about 664 cases expected for an observed/expected ratio of 1.11, which is statistically high. This finding is due to statistically elevated pancreas cancer in men. (Table 5 shows further detail about the male pancreas cancers in RSA 205 with observed/expected ratios by race/ethnicity and age.) Excluding the 74 male cases of pancreas cancer results in an observed/expected ratio of 1.07, which is not statistically high (660 "rare" cancer cases compared to about 615 cases expected).

Table 3 – "Rare" Cancers Diagnosed in Ten Regional Statistical Areas (RSAs) in the Vicinity of Rocky Flats 1990-2014, Ratios of Observed to Expected Counts of Cancers - Males				
	Cancers Diagnosed	Cancers Expected[1]	Diagnosed/ Expected Ratio	95% C.I. for Ratio
RSA 103 - "Boulder City - Periphery"	343	424.023	0.81**	0.73-0.90
RSA 106 - "Boulder – Tri-Cities"	1060	1205.016	0.88**	0.83-0.93
RSA 202 - "Standley Lake"	1144	1210.437	0.95	0.89-1.00
RSA 203 - "Arvada"	1300	1307.129	1.00	0.94-1.05
RSA 204 - "Golden"	500	565.386	0.88**	0.81-0.97
RSA 205 - "Wheat Ridge" (excluding pancreas cancer	734 (660)	663.853 (614.561)	1.11** (1.07)	1.03-1.19 (0.99-1.16)
RSA 301 - "Adams - Northwest"	826	923.292	0.90**	0.83-0.96
RSA 304 - "Adams - West"	1412	1496.731	0.94*	0.89-0.99
RSA 305 - "Adams – Clear Creek Valley"	595	641.341	0.93	0.85-1.01
RSA 306 - "Northglenn - Thornton"	1149	1146.396	1.00	0.94-1.06
Total 10-RSA	9063	9463.977	0.96*	

[1]Expected cancer counts based on cancer rates of the Denver Metro area outside the total 10-RSA area seen on the map in Figure 1.

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* Ratio is statistically significant at p=0.05 level. (** p=0.01 level)

Source: Colorado Central Cancer Registry, Colorado Department of Public Health and Environment

Table 4 – "Rare" Cancers Diagnosed in Ten Regional Statistical Areas (RSAs) in the Vicinity of Rocky Flats 1990-2014, Ratios of Observed to Expected Counts of Cancers - Females				
	Cancers Diagnosed	Cancers Expected[1]	Diagnosed/ Expected Ratio	95% C.I. for Ratio
RSA 103 - "Boulder City - Periphery"	375	368.593	1.02	0.92-1.13
RSA 106 - "Boulder – Tri-Cities"	1118	1174.651	0.95	0.90-1.01
RSA 202 - "Standley Lake"	1122	1166.879	0.96	0.91-1.02
RSA 203 - "Arvada"	1353	1338.912	1.01	0.96-1.07
RSA 204 - "Golden"	464	484.406	0.96	0.87-1.05
RSA 205 - "Wheat Ridge"	713	737.221	0.97	0.90-1.04
RSA 301 - "Adams - Northwest"	816	888.619	0.92*	0.86-0.98
RSA 304 - "Adams - West"	1400	1447.787	0.97	0.92-1.02
RSA 305 - "Adams – Clear Creek Valley"	670	632.111	1.06	0.98-1.14
RSA 306 - "Northglenn - Thornton"	1147	1160.299	0.99	0.93-1.05
Total 10-RSA	9178	9342.515	0.98	

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* Ratio is statistically significant at p=0.05 level. (** p=0.01 level)

Table 5 shows further detail about the male pancreas cancers in RSA 205 with observed/expected ratios by race/ethnicity and age. The count of 74 males with pancreas cancer compares to an expected count of about 49 cases for a statistically high observed/expected ratio of 1.50. Observed/expected ratios were statistically higher for non-Hispanic whites (1.61) and the age 65-74 cohort (1.63).

Cell types of the pancreas cancers were similar to the comparison Metro Denver distribution with adenocarcinomas and carcinomas accounting for 88% of RSA 205 male pancreas cancers and 85% of male pancreas cancers in the standard comparison area.

According to the American Cancer Society (https://www.cancer.org/cancer/pancreatic-cancer/causes-risks-prevention/risk-factors.html), smoking is one of the most important risk factors for pancreatic cancer. The risk of getting pancreatic cancer is about twice as high among smokers compared to those who never smoked. About 20% to 30% of pancreatic cancers are due to smoking. Among the male pancreatic cases in RSA 205, about 68% had a history of tobacco use according to Cancer Registry records. Another risk factor may be heavy alcohol use and 18% of these cases had a history of heavy alcohol usage while 64% had a history of at least some alcohol use per Cancer Registry records. Being overweight or obese is another risk factor with obese people being about 20% more likely to be at risk. Per the Cancer Registry Body Mass Index (BMI) information recorded on abstracts beginning in 2011, among the ten male cases diagnosed since 2011, seven had BMI data. Of these seven cases 43% were overweight or obese, which is close to the percentage (45%) of overweight or obese found in the comparison Metro Denver male pancreas cases over that time period. Workplace exposures to chemicals used in dry cleaning and metal working industries have also been implicated as a risk factor for pancreatic cancer. Cancer Registry records showed no particular pattern of types of occupation or industries for these male pancreas cancer cases.

Other risk factors for pancreatic cancer include: a family history of pancreas cancer (at least six different inherited genetic syndromes have been linked with pancreatic cancer); diabetes (which may be correlated with being overweight or obese); chronic pancreatitis especially in smokers (this is described as a long-term inflammation of the pancreas); and cirrhosis of the liver, which increases the risk of pancreatic cancer (it develops in people with liver damage from things like hepatitis and heavy alcohol use).

Table 5 - "Wheat Ridge" Regional Statistical Area (RSA 205) 1990-2014, Ratios of Observed to Expected Counts of Pancreas Cancers by Race/Ethnicity and by Age - Males

Race/ Ethnicity	Cancers Diagnosed	Cancers Expected[1]	Diagnosed/ Expected Ratio	95% C.I. for Ratio
White Non-Hispanic	72	44.786	1.61**	1.26-2.03
Hispanic	2	3.472	0.58	NC
Black	0	0.341	0.00	NC
Other	0	0.693	0.00	NC
Age				
0-34	0	0.115	0.00	NC
35-44	1	0.883	1.13	NC
45-54	8	3.597	2.22	0.96-4.38
55-64	15	9.045	1.66	0.93-2.74
65-74	23	14.082	1.63*	1.03-2.45
75+	27	21.570	1.25	0.82-1.82
Total	74	49.292	1.50**	1.18-1.89

[1]Expected cancer counts based on cancer rates of the Denver Metro area outside the total 10-RSA area seen on the map in Figure 1.

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* Ratio is statistically significant at p=0.05 level. (** p=0.01 level)
NC = not calculated due to less than 3 diagnoses

Source: Colorado Central Cancer Registry, Colorado Department of Public Health and Environment

Summary

Thyroid Cancer

Thyroid cancer was not evaluated in the original CDPHE Rocky Flats cancer incidence studies because it was not included in the ten types of cancer recommended by the Health Advisory Panel on Rocky Flats as being possibly linked with plutonium exposure. In the supplemental analysis just completed, there was no evidence of higher than expected frequencies of thyroid cancer in the vicinity of Rocky Flats during 1990-2014. Thyroid cancer was not higher than expected for the entire 10-RSA area combined for males or females compared to the remainder of the Denver Metro area.

None of the ten RSA areas had statistically higher than expected counts of thyroid cancer for males or females over this time period. Some RSA regions had statistically lower than expected thyroid cancer counts compared to the remainder of the Denver Metro area.

"Rare" Cancers

For the entire 10-RSA region combined, the incidence of "rare" cancers was not higher than expected for either males or females compared to the remainder of the Denver Metro area.

Nine of the ten RSA regions for each gender had incidence of "rare" cancers that was not higher than expected compared to the remainder of the Denver Metro area. One of the ten RSA regions, RSA 205, "Wheat Ridge", had a statistically higher than expected count of "rare" cancers for one gender, males, a finding explained by higher rates of male, pancreatic cancer. Pancreas cancer has many risk factors associated with it, among which are smoking, heavy alcohol use, being overweight or obese, family history of the disease, and diabetes. Over 2/3 of male pancreas cancer cases in this area had a history of smoking and some evidence of alcohol use was also documented.