

The July 15th Westminster Study Session on the Rocky Mountain Greenway

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This document is written for several reasons, and may be useful in several different ways:

- To identify tone-deaf deficiencies of a local municipality's [Westminster City Council] process for a 'study session' (possibly useful to *other* city councils) on a controversial topic
- As a report to those following the Rocky Mountain Greenway story
- As an account of how easy it is to bamboozle unprepared people
- To rebut some of the factually incorrect statements by anti-nuclear spokesmen, with citations to the scientific literature
- Those interested in the presentation I gave (and older transcripts, a brief bibliography, a 4-page summary of pertinent science, and summary statements) should visit [this page](#).

To me the City Council was a victim of naiveté. They believed that a meaningful comprehension of radiation and health could be achieved by asking 6 anti-nuclear spokesmen with zero expertise and a single physicist allotted 10 minutes. This is like having a COVID study session with a virologist and 6 anti-vaxxers.

1 How not to set up a 'study session': sketchy process, asymmetric representation

The 'study session' concerned a historically polarizing subject, the safety of the Rocky Flats National Wildlife Refuge and Rocky Mountain Greenway connections to it. A plausible process *would have been* to identify credentialed spokespeople for the two sides of the issue well before the session and give them equal time to present their arguments. Instead, what happened (in my case, as a spokesman both for people living around the Refuge and for the physical science side) was

1. June 5th: I learned from a friend that 6 Rocky Mountain Peace & Justice Center-affiliated people had *already been scheduled* to speak (on July 15th). I suspect a City Council member in the anti-nuclear camp.

Jon Lipsky, Dr. Michael Ketterer, Dr. Deborah Segaloff, Randy Stafford (of 'Rocky Flats Public Health Advocates'), Sasha Stiles, MD, Diane D'Arrigo (Radioactive Waste Project Director at the Nuclear Information and Resource Center, from a staff of four).

I requested confirmation of these participants and requested that I be permitted to speak, citing my credentials, previous presentations, and by documenting that the groups above did not speak for people living *around* the Refuge.

2. June 6th-7th: I asked who was presenting **in support** of the Greenway. No answer, but was assured that "... the City Council asked that the presentation be balanced." My list was confirmed.
3. June 7-July 7: No response about speaking
4. July 8th: I learned I *can* speak (after three requests), but my presentation is due TODAY and is 10 minutes long.

2 Overview

The July 15th Westminster City Council "study session" was attended by the usual contingent of anti-nuclear activists. Several Westminster employees and external technical representatives gave reports about statutory compliance, and the pro-Greenway speakers included me, David Lucas of Fish&Wildlife, Jason Andrews (Engineering Analytics), and Tom Hoby, Jeffco Open Space director. In some sense, other speakers were essentially stating that "Our measurements and plans meet the safety standards and we will proceed". While this is good to know, *my* intent was to convey an intuitive and quantitative understanding of why radiation doses from plutonium are *extremely* low: (i) it accounts for only about 0.8% of soil radioactivity and should contribute well under 0.8% of radiation *dose*; (ii) RESRAD confirmed that in fact it is *much* less.

Most of the Greenway is completed and the bridge installation I believe will begin on September 24th. It will probably cost Westminster to back out now (fortunately, too late to have much impact), not to mention opening them to lawsuits like the one Jefferson County and Arvada brought against Broomfield for withdrawing from the Jefferson Parkway project.

As I noted in the rockyflatsneighbors.org [blog entry](#) *Another municipal lamb to the Rocky Flats nonsense slaughter* on March 12 (posted April 12) it appears that Westminster would back out of supporting the Greenway if it could. If they *do* manage to block the bridge, headlines like HIKER KILLED CROSSING INDIANA ST TO VISIT REFUGE will gain much more attention once it is learned that *the bridge was actively opposed by the City of Westminster*. You can bet wrongful death attorneys will be all over that.

Anti-Greenway speakers were the same pair of Ph.D chemists who know nothing about radiation dose who spoke in March, a software

developer who won't use Google Scholar, knows no epidemiology, and cites anecdotal, a former FBI agent who believes in buried radioactivity (contradicting what's measured and nowhere on the DOE's current subsurface map for the Central Operable Unit) and an anti-nuclear technician who is unfamiliar (despite training) with RESRAD.

The usual vulnerabilities were exploited by the anti-nuclear spokespeople:

- The notion that plutonium is deadly in *any* amount and that any plutonium is a sign of an inadequate Superfund cleanup. (Hand in hand: 'a single hot particle will cause cancer'.) The basic principle of toxicology is "the dose makes the poison". The natural biotoxin used as Botox is about 1 million times more toxic (LD50) than plutonium, for instance.
- The city council, like most of the public, cannot tell when information is being omitted, distorted, or entirely fabricated—examples below.
- That *anecdotes* are meaningful evidence. There is a reason that careful epidemiology[1] rejects anecdotal data out of hand after preliminary work. The quantitative relation between health risk and radiation **dose** has been well established for more than 60 years.

3 Rebuttals to specific statements

Jon Lipsky

Mr. Lipsky focused on aspects of the cleanup he did not like, detailed history, and took a gratuitous poke at RESRAD (more below). For Refuge users what is *currently present* and what *has been measured* is relevant.

Mr. Lipsky stated, "Bridge abutments and piers will most likely be buried more than six feet deep, where weapons grade plutonium 239 has no standard", implying that excavation would be dangerous. [There is no such thing as 'weapons grade Pu 239', only weapons grade plutonium, which places limits on amounts of ²⁴⁰Pu and ²⁴¹Pu.] 'Having no standard' does not mean catastrophically large! There is no 'standard' for the Refuge since it is on land identified as not requiring mitigation. [Total soil radioactivity is *already* about 53 pCi/g due to natural radioisotopes.] Fig. 1 shows what is measured. *There is no evidence anywhere in the Refuge or COU that soil Pu levels rise with depth—precisely the opposite.*

They can *ex post facto* examine the hallmarks of pseudo-science and conspiracy theory practices.

In 2016 Quentin Young in his article *Rogue Agent* in 5280 noted, "[David] Abelson [Rocky Flats Stewardship Council] also raises doubts about the raid, which he says "was based on premises that later turned out not to be accurate." Abelson says the alleged nighttime incineration of plutonium never occurred. . . . That opinion is shared by [William] Smith, Lipsky's EPA partner on the Rocky Flats investigation. "Jon thought it happened, and I was 100 percent sure it didn't happen . . . "Jon kind of went off the deep end," Smith says. "He started seeing conspiracy theories in everything."

The solution of the one-dimensional diffusion equation is appropriate for a surface deposit of a substance spreading in time and space. It is a (very good) fit to this form shown below.

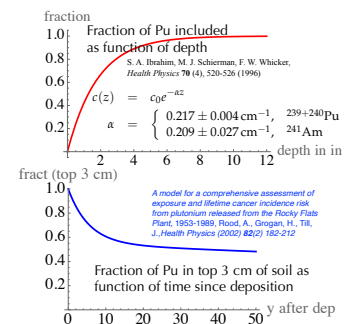


Figure 1: Top: fit to measured data for the depth dependence of Pu in the Central Operable Unit; probably extremely similar throughout Refuge; bottom: measured fraction of Pu in top 3 cm of soil over time.

Michael Ketterer

Dr. Ketterer reported finding plutonium in the air (via mass spectrometry of burned air filters) as if this was alarming and unexpected. (Desired response from an unsophisticated listener: OMG there's PLUTONIUM in the air!) See Fig. 2.

Neither is true—every dose estimate made by the CDPHE or the DOE has included airborne Pu as the **main source** of Pu exposure, as inputs to RESRAD in the form of inhaled grams of soil per year and swallowed grams of soil per year. The working assumption for decades is that the concentration of Pu in 'suspended' dust in the air mirrors that in the soil. Ketterer's work simply confirms what is expected. (We also know the statistics from the 2019 sampling: the peak value Ketterer and Lipsky found is close to what I used when showing annual radiation doses in my presentation. About 90% of the 522 Jefferson Parkway samples were below the Ketterer/Lipsky value.)

Ketterer claims "Encouraging more usage and land disturbances in the "Krey-Hardy plume" contaminated areas of the Refuge and/or COU will accelerate the rate of soil loss, and ultimately result in increased deposition of Rocky Flats plutonium-contaminated soils and particles towards receptor areas" [people].' [Since the 1990s the 'Krey-Hardy' map has been considered deficient.]

Ketterer has never followed through on claims of this sort—he has no familiarity with the DOE data or the scientific literature, no idea about radiation doses. He has not respected the scientist's obligation to at least be well informed about topics he reports to the public, such as radiation *dose*, without which the implication of harm is simply fearmongering. Here, Ketterer should have tried to demonstrate that (i) foot traffic exceeds the effects of wind in moving soil off the Refuge and (ii) off-site Pu levels have been increasing. This is not true: the lower panel in Fig. 1 above shows *measured* Pu levels over time, showing that they may still be **dropping**. Read the remarks about Deborah Segaloff's foot traffic claims below.

Deborah Segaloff

Dr. Segaloff's statement focused on the genetic effects of plutonium's alpha particle emissions, its half-life, and the perils of finishing the Greenway.

The emphasis on the 24,100 year lifetime of ²³⁹Pu perils is an embarrassment to herself: ²³²Th (the origin of about 35% of soil radioactivity) has a 14.2 billion year half-life. She *failed to note* (probably from ignorance) that DOE measurements all over Rocky Flats indicate that 99.4% of *total* soil alpha particles (and thus what is inhaled)

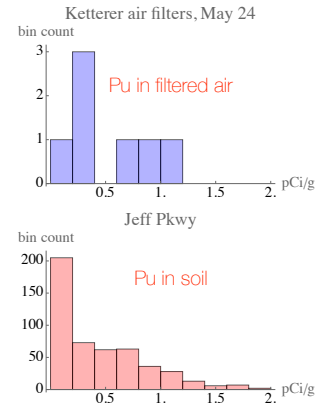


Figure 2: Top: Histogram of 7 Ketterer air filter samples. Bottom: histogram of 522 Jefferson Parkway samples on eastern edge of Refuge.

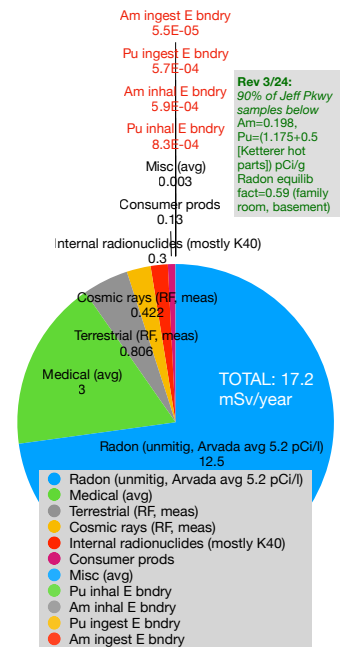


Figure 3: Dose pie chart used in DMW presentation.

Dr. Segaloff didn't quite appreciate how revealing her statements are. She assured us she worked with radioisotopes in her career but knows nothing about radiation doses. Glad I didn't work in her lab! Her acumen may be judged from her anecdote about having to sell her Candelas house at a loss (sob!) once she learned of Rocky Flats plutonium. Most people living here did their due diligence BEFORE moving.

come from natural radioisotopes. She states, “The inhalation of a single particle of plutonium poses a health hazard.” This is no less true of *any* alpha emitting radioisotope. [Does she mean an atom or a ‘hot particle’?] As noted above, 0.6% of inhaled soil alpha radiation comes from plutonium.

She went on, “Installation of the overpass will greatly disturbed soil on the windblown areas of the Refuge, including soil many feet below the surface, which may be more heavily contaminated than the surface soil.” This issue was dealt with in the Jon Lipsky section above.

“The Greenway would open the gates to tracking plutonium and other carcinogens far outside the refuge, including into the Rocky Mountain National Park, where unsuspecting men, women and children could be put at risk.”

As I observed elsewhere, of the 454 Jefferson Parkway samples on the eastern Refuge boundary, 95% showed values less than 2 pCi/g, 25 times below the nominal standard. Values drop abruptly (see the color coded map [here](#) off the ‘wind-blown area’.) Had she bothered, she could have discovered articles like *Mass transfer of soil indoors by track-in on footwear* which considered, for a variety of shoe treads, what was tracked *onto* a prepared and measured surface. This is a good estimate of what is tracked from one area to another. They noted

- ‘Typically no more than 1 g of dry soil was picked-up irrespective of the sole type. However, the rate of post pick-up deposition varied between sole types. In these tests, a greater proportion of the adhering dry soil was rapidly lost from the treaded sole. . . [for hard surfaces]
- . . . with most of the deposited test soil being set down within the first 5 strides,
- . . . Initial soil contamination is likely to be limited to an area within 7–8 m of the entrance. . .”

On the north side of the Refuge where the link to the Greenway occurs the mean Pu concentration is 0.03 pCi/g (among the lowest in the Refuge). The total soil radioactivity in Rocky Flats soil is about 53.5 pCi/g, about 1800 times larger. Natural soil radioactivity varies by about 2000% around Colorado.

Westminster had better *pray* she is wrong—the Indiana Street crossing is much closer to Denver than it is to Rocky Mountain National Park. *East-bound* foot traffic, according to her argument, will track plutonium through Westminster to Denver. Imagine the lawsuits!

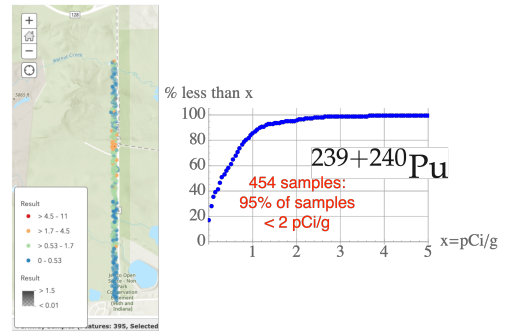


Figure 4: Color-coded Jefferson Parkway sampling results, and fraction of samples with Pu level below x pCi/g (right). Natural radioactivity accounts for about 53. pCi/g.

location	samples	mean	std dev	max	median
southeast	13	1.78	0.95	3.51	1.5
north	20	0.03	0.02	0.08	0.03
southwest	15	0.04	0.02	0.07	0.04

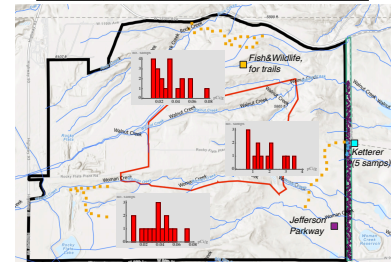


Figure 5: Fish&Wildlife Sampling points, histograms, and summary. Note low values on north.

Sasha Stiles

Dr. Stiles (M.D.) offered nothing substantive, but gave anecdotes of Rocky Flats workers she had treated. (That M.D.s deal with sick people is not surprising.)

Results of careful recent epidemiology for nuclear workers (with citations) may be found [here](#). Because of the very short range of alpha particles, lung cancer is a very plausible effect of inhalation of large quantities of soil containing alpha emitters (for Rocky Flats, more than 99% attributable to natural radioisotopes). There are a number of ‘confounding’ effects in radiation epidemiological studies, the most important of which has always been smoking. Results from a relatively small study [2] (see Fig. 3) show this clearly.

Diane D’Arrigo

Ms. D’Arrigo’s expertise appears to be in challenging nuclear regulations on permissible radiation limits and acting as a watchdog on pro-nuclear groups. (It is important to note that even ICRP standards evolve in time as new epidemiological data comes in.) There are strong objections[3], from the ‘radiation hormesis’ crowd that, at least at low doses (which many regard as 100 mSv or below, to be compared with about 0.002 mSv estimated for 24/7 Pu exposure on the eastern Refuge boundary), health effects of ionizing radiation are overestimated.

Ms. D’Arrigo’s claims about unreliability of the DOE code RESRAD are a testimony to complete lack of expertise. Only a tyro blames her tools. The choice of input parameters are updated and extensively documented[4], with sections such as *Probabilistic analysis to identify parameters with significant effect on dose*. The fact that it is used for licensing nuclear reactors is irrelevant. No one benefits from bias in an internationally used tool.

Randy Stafford

i Rare cancers

Mr. Stafford frequently cites two instances of cardiac angiosarcoma known to him in Five Parks in 2018 as so unlikely that it *must* be due to having inhaled a plutonium ‘hot particle’ This cancer, although rare, is the most **common** of heart cancers.

- I found the license plates GLJ450 and YKO261 in my garage. **What is the probability to find these two particular numbers there?** This sounds astronomically tiny: given the pattern,

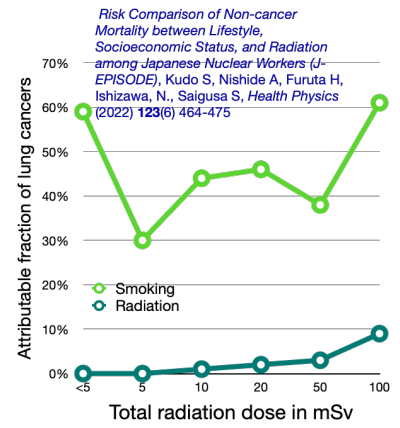


Figure 6: The fractions of lung cancer cases attributable to cigarette smoking and to radiation exposure for a cohort of Japanese nuclear workers.

Ms. D’Arrigo was a chemistry major with course concentration with environmental studies.

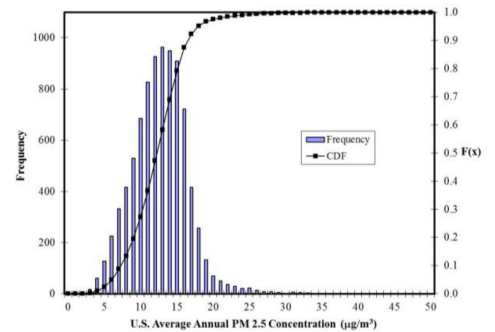


Figure C-27 Mass Loading for Inhalation Histogram and Cumulative Distribution Function for RESRAD-ONSITE

Figure 7: Example of measured distributions relevant to selecting RESRAD default parameters; each can be changed as needed.

Randy Stafford has an undergraduate degree in computer science and a history of over-stating his credentials, sometimes as an ‘applied mathematician’, or a ‘natural scientist’, and claimed to represent 100,000 people when running for a position on the Rocky Flats Stewardship Council. See [instances](#).

about 1 in 3×10^{14} (two independent random choices from finite lists).

But the actual probability is 1. Stafford fell into this simple trap in his eagerness to blame Rocky Flats plutonium for two nearby cases of cardiac angiosarcoma.

- The key is *random sampling of an appropriate population*. In fact, I knew the plate numbers were in the garage *before* posing the question, collapsing the calculation into meaninglessness. (Physicists know this example thanks to Feynman.) Stafford knew about the angiosarcomas by word of mouth (anecdote) since 2018.
- In careful epidemiology any foreknowledge is a form of ‘selection bias’ which should be automatically excluded. The 2016 the RF Downwinders asked a self-selected population (who’d been told for decades to blame Rocky Flats for exotic diseases) to fill out a health survey. This is selection bias compounded by *anecdota*.

ii *Pu levels*

“... Pu is confirmed at levels representing 100s or 1000s of times background radiation, and representing multiples of the allowed cleanup limit”.

Ratios are a childish ploy to enhance alarm. The *dose* depends only on the Pu concentration, not on any ratio. Here’s another ratio: background radiation (dose) is about 420 times *larger* than that from Pu. The 2019 single ‘hot particle’ (264 pCi) is the only significant departure from the 50 pCi/g standard; 85% of values on the eastern Refuge boundary are below 1 pCi/g, 50 times smaller.

iii *Epidemiology*

“...Some studies find greater incidence of cancer closer to Rocky Flats than farther away, and a couple of other studies have found the opposite conclusion.”

Two 1981 studies[5], [6] found higher incidence. Johnson’s work was discredited by 1983. 7 later studies [7], [8], [9], [10], [11], [12] (1983-1998) and ongoing CDPHE reviews [13] have not found elevated rates.

As an example: because of the very short range of alpha particles, cancers of the lungs, trachea, and bronchii would be expected from inhaled alpha emitters like plutonium. Without correcting for population density, areas of high population density would show many cases, appearing to cluster on a conventional map

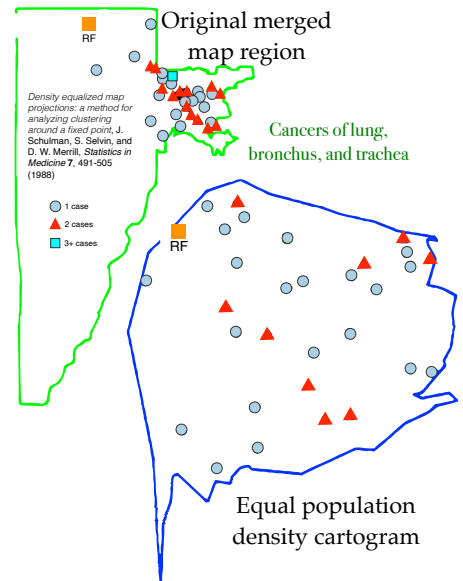


Figure 8: Careful epidemiology for the likely cancers from inhaled plutonium shows, when corrected for very non-uniform population density, **no** correlation with location or distance from Rocky Flats.

(see Fig. 8). By distorting the map to achieve a uniform population density (cartogram in Fig. 8) it is clear that the incidence of cancers is unrelated to the distance from Rocky Flats. Statistical tests for randomness confirm the absence of clustering.

iv RESRAD

“All of the safety determinations about the site are ultimately based on modeling and simulation software called RESRAD. It’s a closed source program...”

Nonsense. Given measured pCi/g and yearly amounts of inhaled and swallowed dirt any health physicist in the world would find about the same results as RESRAD directly from International Commission for Radiological Protection publications. RESRAD has been repeatedly verified and benchmarked, is freely distributed, and used by more than 100 countries. For an ‘applied mathematician’ to reject modeling (there is no simulation in RESRAD) is stunning.

On July 15th Mr. Stafford stated “The modeling and estimation software that is the basis for all of the safety assertions around Rocky Flats [RESRAD] is pretty easily contradicted by empirical evidence in the community.”

In my presentation I concluded that the radiation dose **contributed not more than 0.8% of total soil dose** on the basis entirely of its **measured** contribution to soil radioactivity and nuclear tables for a large number of radioisotopes by the National Institute of Science and Technology. This is multi-national **hard data**. Stafford has zero ‘empirical data:

“Empirical evidence for a proposition is evidence... that is constituted by or accessible to sense experience or experimental procedure.” [Wikipedia]

Stafford confuses this with anecdota: (Longman Dictionary of Contemporary English):

anecdota: information which is presented as if it is the result of serious research, but which is actually based on what someone thinks but cannot prove.

The choice by the Rocky Flats Downwinders to ignore academic advice before distributing their health survey resulted in the termination of cooperation by Metro State University.

Citizen perception of illnesses or cancer clusters has been shown to be often unreliable. Data published in 2012 (see Fig. 10) reviewed the status of cancer clusters within the U.S. Of 567 reported, 0.5% were determined to be due to environmental expo-

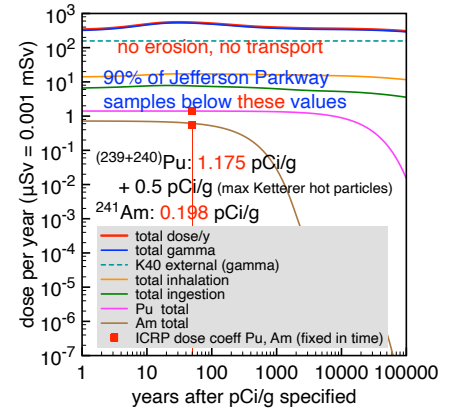
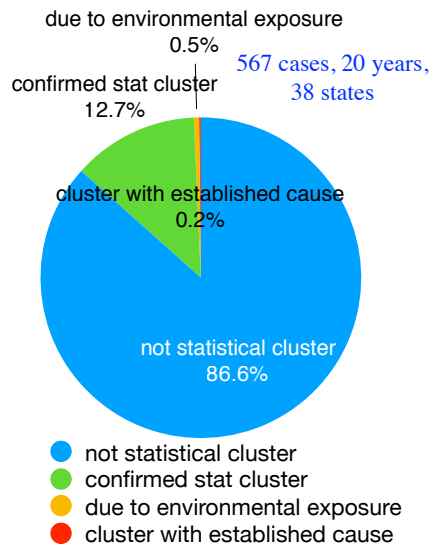


Figure 9: Using *measured* pCi/g values from the NIST soil standard and Pu and Am concentrations above 90% of samples, predicted radiation doses over time. Red filled squares are direct calculations from ICRP dose coefficients.



Michael Goodman et al. “Cancer clusters in the USA: What do the last twenty years of state and federal investigations tell us?” In: *Critical Reviews in Toxicology* 42.6 (2012), pp. 474–490. issn: 1040-8444. doi: 10.3109/10408444.2012.675315. url: <http://www.tandfonline.com/doi/full/10.3109/10408444.2012.675315>.

Figure 10: Results for 567 initially identified ‘cancer clusters’.

sure and 0.2% had an established cause. Only 12.7% even met the criterion of a *statistical* clusters.

4 Summary

Discussion of plutonium, 'hot particles', Pu in filtered air samples, etc. is all *meaningless* without dose and risk estimates. No anti-Refuge groups or spokesmen have *ever* presented these or even indicate awareness of Rocky Flats data and the peer-reviewed literature.

The entire discussion of dose mentioned above and in my presentation is an *ordinary introduction* to radiation and health within the International Commission on Radiological Protection framework. It does not represent my own particular viewpoint, but does use data with which I am familiar.

It's worth taking a more global look at claims of health issues attributable to plutonium. These are just a couple:

- (2012) From the National Academy of Sciences: "Previous smaller studies of mortality or incidence in the United States, such as that around the San Onofre power plant in California (Enstrom et al., 1983), the Rocky Flats nuclear weapon production facility in Colorado (Crump et al., 1987), and Hanford and Oak Ridge in Washington State and Tennessee, respectively (Goldsmith, 1989), showed no evidence of increased risk." [Board2012].
- (2021) From ICRP publication 150 on nuclear workers exposed to plutonium and uranium: "Individual annual exposure data, long duration of health surveillance in the cohort, and validation of the dosimetric models used for individual organ-/tissue-specific dose assessment were the major criteria considered for inclusion of a study in the analysis of lifetime risk." The most remarkable finding is that "It is now possible to estimate the lifetime excess risk of lung cancer following inhalation of plutonium directly from epidemiological studies of plutonium workers."

"... epidemiological studies of environmental exposure to plutonium and uranium do not indicate increased risk of cancer overall..." [italics ours].

In other words, as of 2023 there is no evidence of any increased risk of cancer to the public from plutonium or uranium in the environment anywhere in the world.

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