

**PLUTONIUM AND PEOPLE DON'T MIX**  
**A Guide to Rocky Flats,**  
**Colorado's Defunct Nuclear Bomb Factory**  
by LeRoy Moore, PhD  
Rocky Mountain Peace & Justice Center, August 14, 2013

**Introduction**

Whether to build the Jefferson Parkway, to turn Rocky Flats into a playground or to build homes near Rocky Flats, the determining factor should not be commercial or residential development. The determining factor should be plutonium in the environment. A particle of radioactive plutonium small enough to be inhaled or otherwise taken into one's body is likely to lodge in air sacs of a lung or be transported via blood elsewhere in the organism. Wherever it settles in the body it will continually irradiate surrounding cells in a very small area, typically for the rest of one's life. A single microscopic particle of plutonium inside the body can irradiate more than 10,000 cells within its range. The end result may be cancer, a compromised immune system or genetic harm that can be passed on to future generations.

To get into the body the plutonium has to be in the environment first. At Rocky Flats routine operations and accidents over almost four decades released billions of tiny particles into the air, soil and water. Those responsible for the Superfund cleanup of the site completed in 2005 knowingly left behind an unknown quantity of plutonium. With a half-life of 24,000 years, after ten half-lives, or 240,000 years, it is still radioactive. Thus, from a human perspective, the plutonium in the environment at Rocky Flats poses a local hazard forever.

This danger was totally unknown to the public when on March 23, 1951, the *Denver Post* announced, "There's Good News today. U.S. to Build \$45 Million A-Plant Near Denver." As part of the U.S. effort to mass-produce nuclear weapons the new plant at the foot of the mountains 16 miles northwest of central Denver (see Figure 1) would be the only factory to produce the fissile plutonium "pit" that forms the explosive core of every warhead in the country's nuclear arsenal. Operations began in 1953, with Dow Chemical at the helm.

By 1970 the euphoria vanished as the public learned for the first time about releases into the environment of highly toxic plutonium due to fires, accidents and poor waste management. With the discovery in 1973 of tritium in Broomfield's drinking water, things seemed to go from bad to worse. Then in June 1989 the FBI raided the plant to collect evidence of environmental lawbreaking. A few weeks later, plant operator Rockwell International, which in 1975 had replaced Dow amidst controversy over safety issues, stated publicly that it couldn't meet DOE's production requirements without breaking the law. The next day DOE fired Rockwell and hired EG&G to run the plant. Later that year DOE announced a "temporary" suspension of production. Over the next two years it spent \$1.6 billion trying to get the plant back on line. Finally, in 1992, with many wondering whether the facility had ever been operated safely, or could be, DOE announced a change of mission for Rocky Flats from production to cleanup and closure.

In its 37 years of production the plant produced about 70,000 plutonium pits, each in fact being an atomic bomb like the plutonium bomb that destroyed Nagasaki on August 9, 1945. But most of the pits made at Rocky Flats were "triggers" for thermonuclear or hydrogen bombs, in which the fission explosion of the pit triggers the far more powerful fusion explosion of hydrogen atoms. While other items were made at the plant, its principal product was the plutonium pit. Even today, the pit in every warhead in the U.S. arsenal, except for

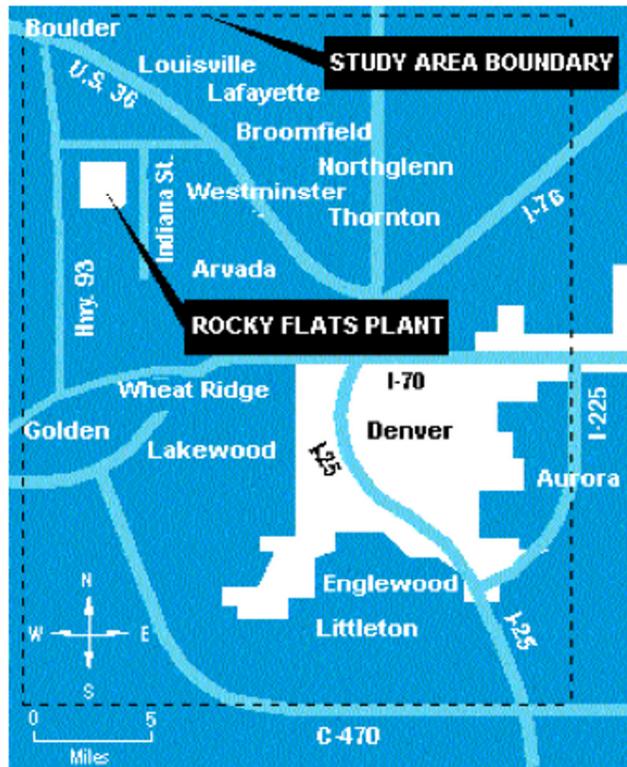


Figure 1: Location of the Rocky Flats plant. From *Summary of Findings: Historical Public Exposure Studies on Rocky Flats*, Colorado Department of Public Health and Environment (August 1999)

no more than 30 made elsewhere, was made at Rocky Flats. Thus, despite being shut down for a quarter of a century, Rocky Flats still poses a global threat.

Hopefully this global threat will soon come to an end, but as the environmental record detailed in these pages demonstrates, the local hazard posed by Rocky Flats will not end. Hence, the necessity for the information conveyed in this Guide. The intended audience is not simply people of the present but more importantly those of future generations. Rocky Flats has given us a responsibility for the future that we must not avoid.

Soon after completion in 2005 of the Superfund “cleanup” of the Rocky Flats site, the Department of Energy (DOE) transferred almost seven square miles of the nearly ten square mile site to the U.S. Fish and Wildlife Service (FWS) to operate as a wildlife refuge (see Figure 2).

Well before land for the wildlife refuge was transferred to FWS, the agency had decided to open the future refuge for public recreation. This Guide elaborates three reasons why this decision should be reversed:

- The site is contaminated with an unknown quantity of plutonium and its daughter product, americium.
- Standards for permissible exposure to plutonium and americium adopted for the site provide inadequate protection for potential visitors to the refuge because the standards are based on a flawed method of risk assessment and a truncated view of the toxicity of these materials.
- In addition, those responsible for the Rocky Flats “cleanup” did not consider crucial data regarding environmental conditions at the site.

Together, these points add up to a great weight of uncertainty that underscores the need for caution. Such caution, unfortunately, was not practiced by the government and corporate entities responsible

for environmental conditions at Rocky Flats. In documenting some of what they have done or not done, this Guide shows why it is likely that totally unsuspecting persons will be exposed to hot particles of plutonium, either in the near term or in the far distant future after memories fade and fences fall. The Guide makes the case for long-term Nuclear Guardianship for Rocky Flats.<sup>1</sup> Indeed, the Guide itself is an example of applied Nuclear Guardianship, since the beginning of Guardianship is informing the affected population.

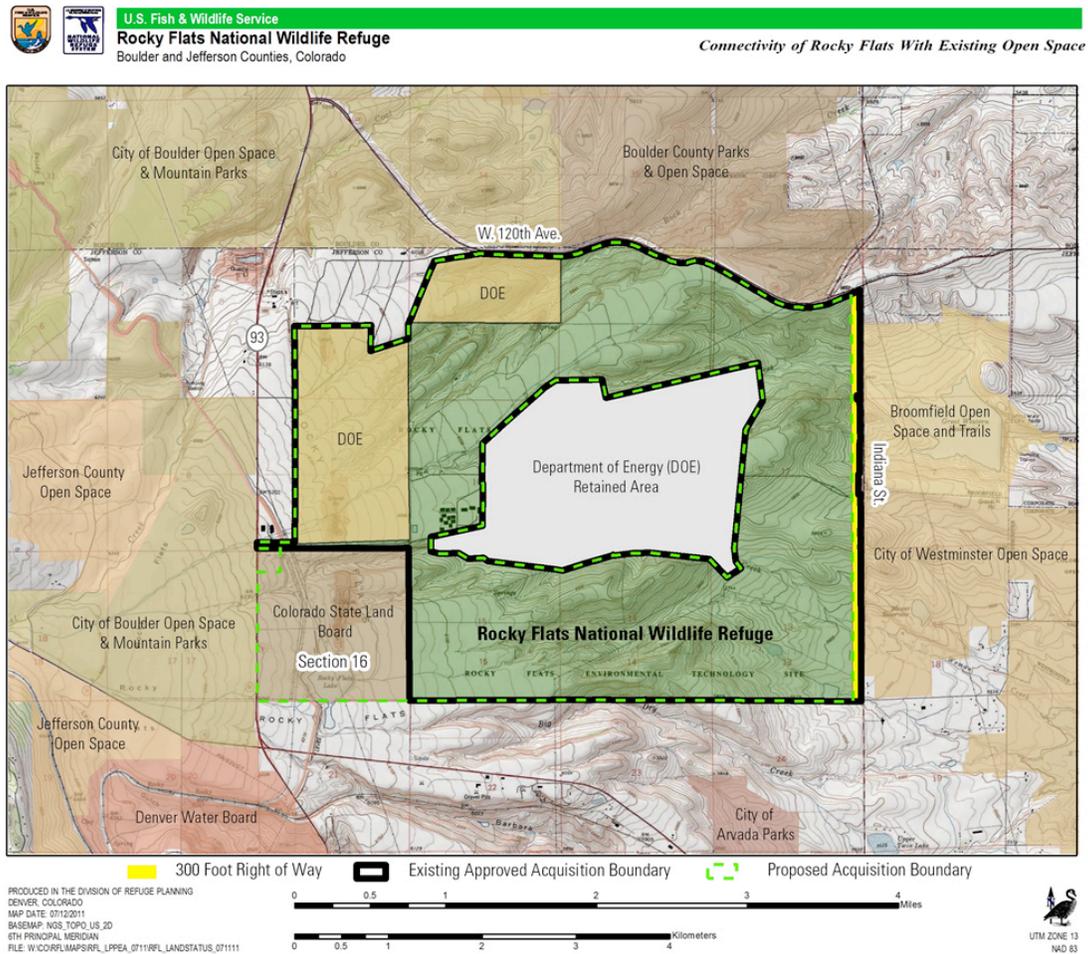


Figure 2. This map shows the 1,309-acre plot retained by the DOE at the center of the Rocky Flats site. The surrounding green area of 4,465 acres is the Rocky Flats National Wildlife Refuge managed by FWS. The two tan plots marked DOE are areas where private interests mine gravel; when their mining rights expire, these plots will be transferred to FWS. Section 16 in the SE corner was recently transferred to FWS as part of the deal by which FWS ceded the 300-foot-wide yellow strip of land along the eastern edge of the site for construction of the proposed Jefferson Parkway, discussed in Chapter 7 below.

<sup>1</sup> See <http://www.rockyflatsnuclearguardianship.org/>

## 1. A HISTORY OF CONTAMINATION WITH PLUTONIUM & AMERICIUM

The principal isotope or form of plutonium in bombs is plutonium-239. Considerable quantities of this highly toxic material were released as minuscule particles into the Rocky Flats environment. In this paper plutonium-239 is referred to simply as plutonium.

The special danger of alpha radiation from plutonium: The half-life of plutonium-239 is 24,110 years; it remains dangerously radioactive for more than a quarter-of-a-million years. It emits radiation in the form of alpha particles that pose little danger outside the body, but if particles are inhaled or otherwise taken into the organism, especially via an open wound (say, a child's scraped knee or elbow), they can cause cancer, malfunction of the immune system or genetic defects that can be passed on to future generations. From a human standpoint, plutonium's public health danger is twofold: it poses an essentially permanent hazard, and particles too small to see but not too small to do harm can wreak havoc if taken into the body.

The increased radiation from americium: The amount of alpha radiation given off by material in the Rocky Flats environment actually increases with time, thanks to the presence in the original bomb-grade material of a small quantity (0.4%) of plutonium-241.<sup>2</sup> Plutonium-241 has a half-life of 14.3 years. As it decays, it becomes americium-241, an alpha emitter with a half-life of 460 years. In about 75 years, after five half-lives, the alpha activity of the rapidly decaying americium-241 equals half the activity of the plutonium-239 in the original mix of material purified for bomb production.<sup>3</sup> This means that, for a period of time beginning around 2030 and tapering off after 2065 the total alpha radiation emitted by plutonium and americium remaining in the Rocky Flats environment will be at a level 50% higher than this same material emitted when it was first deposited in the environment.

Distinct periods of Rocky Flats history:

- 1952-1989: These, the production years, were punctuated by routine and accidental releases of plutonium to the external environment. In November 1989, five months after the June FBI raid on the plant to collect evidence of environmental lawbreaking, the DOE announced that production had been "temporarily" suspended for safety reasons; it never resumed.
- 1989-1992: The limbo of unsuccessful efforts to get the facility back on line ended in 1992 with a change of mission from production to cleanup.
- 1992-2006: The move to closure, which intensified in 1996, entailed relocation of weapons-grade material, removal of bomb-production waste, scaling back of the high security necessary during production years, demolition of buildings, and "cleanup" or remediation of the environment in compliance with standards set by DOE and the regulators.
- 2006 and following: After certification of the Rocky Flats "cleanup," DOE transferred 4,465 acres of land (roughly 7 square miles) to FWS to operate as a wildlife refuge. DOE's Legacy Management Office retains 1,309 acres (about 2 square miles) in the more contaminated central part of the site, the "hole" surrounded by the FWS "donut." DOE holds 720 additional acres where other activity occurs. This paper focuses primarily on conditions at the site after the land transfer.

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<sup>2</sup> Lamm-Wirth Task Force on Rocky Flats, Final Report, October 1975.

<sup>3</sup> S. E. Poet and E. A. Martell, "Plutonium-239 and Americium-241 Contamination in the Denver Area," *Health Physics*, vol. 23, Oct. 1972, p. 545.

How much plutonium was released to the environment? No one knows how much was released or where it went. P. W. Krey of the Atomic Energy Commission (AEC, predecessor to DOE) sampled soil throughout the metro area in an effort to find out. In 1976 he published a map showing that plutonium released from Rocky Flats was deposited southeast from the plant across most of the City of Denver and east as far as Thornton, with heavier concentrations nearer the plant (see Figure 3). A more comprehensive effort, the Rocky Flats dose reconstruction study, estimated that the total quantity of plutonium released from Rocky Flats to the off-site environment ranged from 4.8 to 51.3 curies (in weight, 66.3 to 704 grams, or 0.15 to 1.5 lbs.).<sup>4</sup> One curie is the quantity of any radioactive material that undergoes 37 billion disintegrations or releases of radiation per second. Thus, according to the dose reconstruction estimate, plutonium released off site and distributed over a very large area emits between 176.6 billion and 1.9 trillion bursts of alpha radiation each second. After 24,110 years, plutonium-239's half-life, the number of alpha bursts per second will be reduced by half. The dose reconstruction study was based on an exhaustive search for documentation, but those who did the study had to rely on manifestly incomplete data provided by DOE. To cite only the most egregious example of incomplete data, on June 27, 1994, then-Energy Secretary Hazel O'Leary revealed an inventory shortfall at Rocky Flats ("material unaccounted for," or MUF) of 1.2 metric tons (MT) of plutonium, or 1.2 million grams (2,640 pounds).

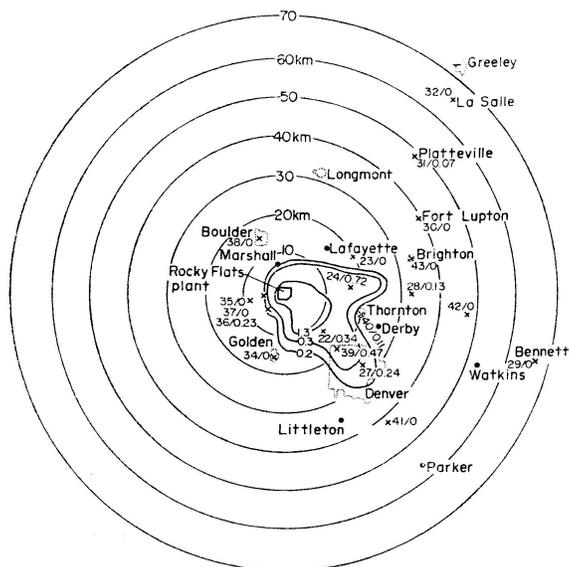


Figure 3. P. W. Krey's soil sampling sites are designated by X. The first of the adjacent pair of numbers to the site represents his site number. The second (following the slash) is Rocky Flats plutonium in millicuries per square kilometer (mCi/km<sup>2</sup>) measured at that site (one millicurie is 1/1000th of a curie). The heavy irregular lines of the isopleths show the concentration of Rocky Flats plutonium in soil within the bounded area in mCi/km<sup>2</sup>. The concentric arcs reflect the radial distances from the center of the Rocky Flats plant. (Krey, "Remote Plutonium Contamination and Total Inventories from Rocky Flats," *Health Physics*, vol. 30, Feb. 1976, p. 210)

Nuclear physicist Thomas B. Cochran of the Natural Resources Defense Council insists that some unknown portion of this huge quantity of MUF was released to the external environment. In testimony given in the class action lawsuit brought on behalf of property-holders in areas shown in 1970 by AEC scientists P. W. Krey and E. P. Hardy to be contaminated with plutonium released

<sup>4</sup> Summary of Findings, Historical Public Exposures Studies on Rocky Flats. August 1999, Colorado Department of Public Health and Environment (CDPHE).

from Rocky Flats (see Figure 4), Cochran explained his unsuccessful effort to get the DOE to declassify some of its vast store of documents on the plutonium unaccounted for at Rocky Flats.<sup>5</sup> He

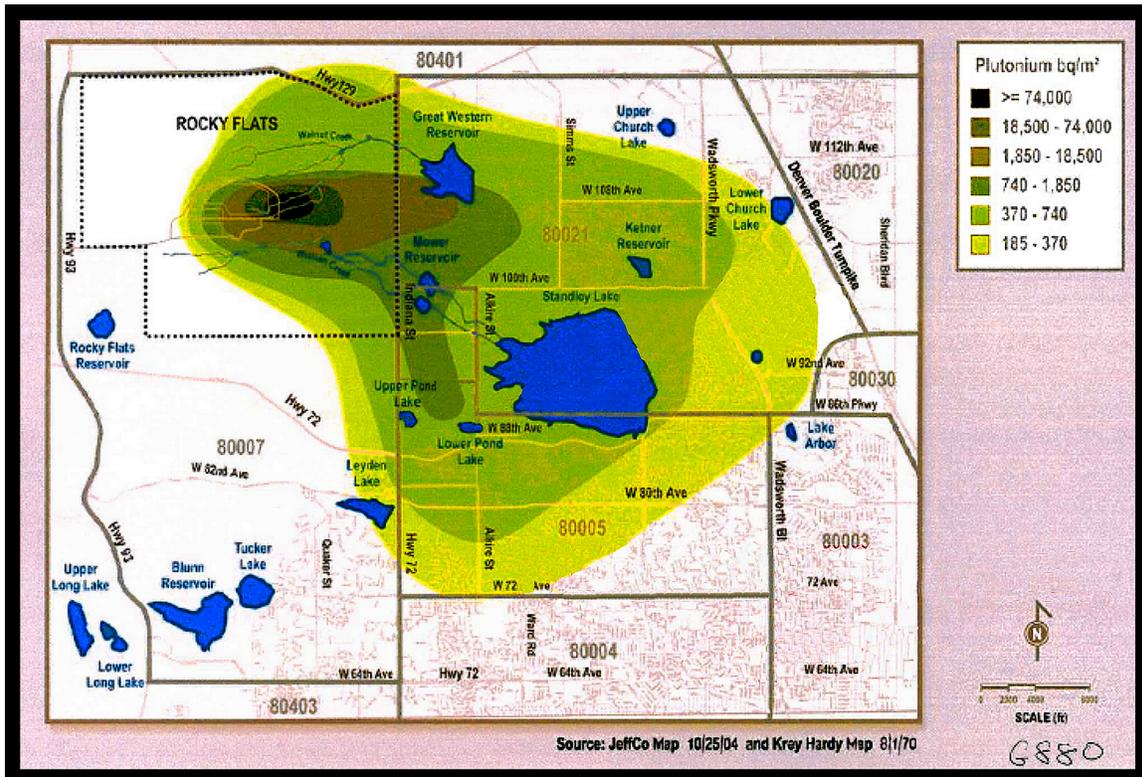


Figure 4. Distribution of plutonium contamination from Rocky Flats in becquerels per square meter (one becquerel equals one disintegration or burst of radiation per second). The original version of this map was prepared by P. W. Krey and E. P. Hardy of the AEC's Health and Safety Laboratory, New York City, and published in their 1970 report, "Plutonium in Soil Around the Rocky Flats Plant," HASL 235. The above adaptation of their map was used to delineate the area of the class of affected property owners seeking compensation for damage to their property in the Cook v. Dow & Rockwell lawsuit heard in Denver federal court and decided by the jury against the corporations in February 2006. This verdict was reversed by the Appeals Court in September 2010. In June 2012 the Supreme Court decided not to hear the case and remanded it back to the original court. Whether the case will be retried has yet to be determined.

said in the conclusion to his pre-trial deposition that the plutonium release estimates cited above "could be increased by orders of magnitude [ten or more times] and still be consistent with the MUF."<sup>6</sup> The truth about the MUF and releases to the environment remains a great unknown. *The United States Plutonium Balance, 1944-2009* (2012), a DOE report says that most of the missing plutonium went to the Idaho National Lab for burial prior to 1970.<sup>7</sup> However, there has been no independent assessment of this claim, and it is countered by a series of three closely documented articles published in *Westword* in 2001 by Pulitzer Prize winning journalist Eileen Welsome, who, working with environmentalist Adrienne Anderson, showed that a very large quantity of plutonium

<sup>5</sup> See his extensive testimony in Cook v. Rockwell International, United States District Court, District of Colorado, No. 90-CV-00181, pp. 5230-5655.

<sup>6</sup> "Plutonium Inventory Differences at the Rocky Flats Plant and Their Relationship to Environmental Releases" <http://www.nrdc.org/nuclear/cochran/cochranpubs.asp#pubs>

<sup>7</sup> <http://nnsa.energy.gov/ourmission/managingthestockpile/plutoniumpits/puinventory>

waste from Rocky Flats was illegally dumped at the Lowry Landfill southeast of Denver.<sup>8</sup> The estimates given above refer to off-site releases; estimates for on-site releases are not available. From an environmental perspective, any portion of the site as it now exists in its two main parts, the FWS donut or the DOE center (see Figure 1), contains plutonium deposited in the past, minus what was removed as part of the “cleanup,” plus or minus what has been added or subtracted and continues to be added or subtracted by the ongoing processes of wind, water, gravity, animal and plant activity plus possible human intrusion. The resultant reality is fraught with enormous uncertainties. In any case, the amount of plutonium remaining in the Rocky Flats environment is dependent largely but not solely on the standards according to which the site was “cleaned.” These standards will be dealt with in section 3 below.

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<sup>8</sup> See <http://www.westword.com/authors/eileen-welsome/>

## 2. FAILURE TO CREATE A RELIABLE RECORD OF CONTAMINATION

In addition to the history of contamination at Rocky Flats is the history of failure of DOE and its contractors as well as of the Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE) carefully and accurately to document this contamination. A reliable record of contamination at Rocky Flats thus does not exist.

The whole of the Rocky Flats site was contaminated with tiny plutonium particles: Harvey Nichols, PhD, emeritus professor of biology at the University of Colorado, was asked by the Energy Research and Development Administration (ERDA, predecessor to DOE) in 1975-76 to study airborne particles at Rocky Flats. He found that snow samples from across the whole of the Rocky Flats site, including in areas known to be predominantly upwind, were radioactively “hot.” He estimated that about 14 million radioactive particles per acre were deposited on the site in less than two days of snowfall. Tiny particles of plutonium released from the stacks in routine operations had been “scavenged from the air by falling snow.” He concluded that over the years, the entire Rocky Flats site, including what today is the National Wildlife Refuge, was dusted with “up to tens of billions of plutonium particles per acre.”<sup>9</sup> Since no “cleanup” was done in the land that is now the refuge, most of these particles remain in the environment, percolated down a bit perhaps, but still there.

Inadequacy of air monitoring: Meteorologist W. Gale Biggs, PhD, who in the 1980s was appointed by then-Governor Roy Romer to assess air-monitoring at Rocky Flats, insists that airborne particles of plutonium were not fully detected by the air monitors at Rocky Flats. Because the particles were so tiny “probably smaller than 0.01 microns” most of them passed undetected through the filters of any air monitors they might have reached. To get a sense of how small this is, it helps to realize, he said, that the average diameter of human hair is about 50 microns.<sup>10</sup> His critique supports the evaluations of the air monitoring devices made by Harvey Nichols, who, as pointed out in the previous paragraph, in the 1970s did government funded research on air transport of radioactive particles at Rocky Flats. He found that the air samplers were not efficient at collecting small lightweight particles because they did not pivot into the wind, did not compensate for changes in wind speed, and were roofed in a way that prevented intake of many particles.<sup>11</sup> Both these independent scientists concluded that Rocky Flats air-monitoring data reported periodically in the past by CDPHE and other agencies misrepresented reality and provided false assurance.

Respirable dust not sampled: There has never been a program at Rocky Flats for routine collecting of discrete samples of respirable dust and analyzing each sample for plutonium and americium content. This type of sampling would demonstrate the extent to which plutonium and americium are present at the time of the sampling in breathable particles, the most dangerous way for humans to be exposed. Those responsible for the Rocky Flats “cleanup” derived their data on plutonium and americium in surface soil from about 4,400 samples. This impressive number, however, produced misleading results, because the samples collected were whole soil samples. CDPHE’s sampling method collects the top quarter-inch of soil, which includes dust but dilutes it by mixing it with other matter.

There’s a little known history here. Sampling surface dust for plutonium occurred in 1975, perhaps for the very first time anywhere, on land east or downwind of the Rocky Flats site. Dust

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<sup>9</sup> Nichols, Final Report on ERDA Contract EY-76-S-02-2736 and personal communications dated November 21, 2003, and October 15, 2009. See also Nichols “Statement in support of Rep. Wes McKinley’s House Bill on Rocky Flats signage.”

<sup>10</sup> Biggs, “Emissions and Monitoring of Plutonium from Rocky Flats,” April 26, 2007. See also Biggs, Airborne Emissions <http://rmpjc.org/rocky-flats/>

<sup>11</sup> Nichols, “Pollen and spores as vectors of radionuclide particles at the Rocky Flats facility, Colorado,” First Progress Report for US ERDA under Contract No. E (11-1) - 2736, October 15, 1975; and “Some aspects of Organic and Inorganic Particulate Transport at Rocky Flats,” Final Report for US ERDA on Contract EY-76-S-02-2736, prepared for US ERDA in 1977. See also Nichols on Air Sampling at RF <http://rmpjc.org/rocky-flats/>

samples were taken at 25 locations by Dr. Carl J. Johnson, then head of the Jefferson County Health Department, and two soil-science specialists from the U.S. Geological Survey. They found plutonium concentrations, on average, 44 times greater than what had been measured at the same locations in previous surveys with the method of whole-soil samples used by the Colorado Department of Health (CDH), as CDPHE was then called. When the Jefferson County Commissioners, who had mandated the dust sampling, saw the results, they vetoed a residential development proposed on the land in question, a project previously approved by CDH. Johnson and his USGS colleagues published their results in an article that continues to be cited by those who do this unique type of sampling.<sup>12</sup>

In October 1975 Johnson formally proposed that, for purposes of assessing health risk in off-site areas, the state set a new standard based on plutonium in respirable dust on the surface of the soil. Coarser materials that cannot be inhaled and retained in the body, he pointed out, have no bearing on actual health hazards; including such material in samples that are analyzed dilutes the amount of radioactivity and provides inaccurate and misleading results. CDH did not welcome this proposal. To settle the matter, state officials brought Dr. Karl Z. Morgan to Colorado in January 1976. Recently retired from the Oak Ridge Lab, Morgan was known as the “father of health physics” because he had pioneered this field as part of the Manhattan Project. He was asked whether the state should adopt Johnson’s respirable dust approach or continue its practice of collecting whole-soil samples. Morgan favored Johnson’s method because it produced results that are more accurate and more protective of the public health. Colorado officials, having gotten the advice they sought, ignored it.<sup>13</sup> There has never been an established program for ongoing sampling to determine the plutonium and americium content in respirable dust in surface soil at Rocky Flats, either on or off the site. The moral of this story is that you can’t find what you don’t look for.<sup>14</sup>

Questionable characterization: While the failure to determine what’s actually present in dust is the bigger problem from a public health standpoint, some of the sampling that was done to characterize areas of the site (locate, measure and map contamination) was inadequate for other reasons. Especially was this so for the “kriging” approach which estimates plutonium and americium concentration in a given area by averaging a very few surface soil samples collected from within a very large plot. This method, which was used for most of the Rocky Flats site, can either miss hot spots or average them away.<sup>15</sup>

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<sup>12</sup> Carl Johnson, R. R. Tidball, and R. C. Severson, “Plutonium hazard in respirable dust on the surface soil,” *SCIENCE*, vol. 193, 6 August 1976, pp. 488-490.

<sup>13</sup> For more details, see Moore, “Democracy and Public Health at Rocky Flats” at <http://www.rockyflatsnuclearguardianship.org/leroy-moores-blog/papers-by-leroy-moore-phd-2/>. Real estate interests gained control of the Jefferson County Commissioners and had Johnson dismissed in 1981.

<sup>14</sup> Rocky Flats Stewardship Council staff Rik Getty and David Abelson searched for examples of dust sampling done at Rocky Flats. In a March 22, 2011, memorandum to the Council they reported that they had found only one example. Following a July 2000 lightning-caused fire that denuded the soil in an area near the 903 Pad, dust collected with a whisk broom as well as in a portable wind tunnel showed very little plutonium content. But the project was flawed in two ways. First, samples weren’t taken until six weeks after the fire, by which time most of the dust in the denuded area would have blown away. Second, the wind tunnel filters captured for analysis only particles that ranged from 10 to 45 microns in size while most of the plutonium particles at Rocky Flats would be small enough to pass right through the filters. (On the size of particles, see discussion of air monitoring on page 5; on the hazard of small particles, see page 9.) Farrel Hobbes, long head of Environmental Management at Rocky Flats, told me that he had once tested surface dust for plutonium content at Rocky Flats back in the mid 1970s. But this was a one-time occurrence, not a program for routine testing of this sort.

<sup>15</sup> See “Rocky Flats Environmental Technology Site: Independent Review and Technical Evaluation of the Soil Sampling Protocols for Site Characterization and Cleanup Confirmation,” a report prepared for the Rocky Mountain Peace and Justice Center by Camp Dresser & McKee, Inc. (August 2005). Go to <http://www.clarku.edu/research/kaspersonlibrary/mtafund/> and scroll down to Rocky Mountain Peace.

### 3. STANDARDS FOR CLEANUP OF PLUTONIUM AT ROCKY FLATS

The Rocky Flats Cleanup Agreement of June 2003 set standards for the “cleanup” that allowed the following quantities of plutonium to be left in soil at the site:

- The top 3 feet of soil: up to 50 picocuries per gram (50 pCi/g) of soil, a picocurie being a measure of radiation (1/trillionth of a curie).
- Soil 3 to 6 feet below the surface: 1,000 to 7,000 pCi/g, the quantity for a particular area of plutonium concentration dependant on its size.
- Soil 6 or more feet below the surface: no limit on the amount of plutonium that may remain.

Comparison to cleanup standards at other sites: How do the numbers just cited compare to standards set for cleanup of plutonium-contaminated sites elsewhere? At the following sites, with one exception, standards are all lower than the 50 pCi/g for the top 3 feet of soil at Rocky Flats. Also, by contrast to the graduated standards for varying subsurface depths adopted for Rocky Flats, the following apply to soil in the environment without respect to depth below the surface.

- 40 pCi/g at the Enewetak Atoll bomb test site
- 14 pCi/g at the Johnston Atoll bomb test site
- 34 pCi/g for a portion of the DOE’s Hanford, WA, site
- 8 pCi/g at Fort Dix, NJ
- 10 pCi/g for a portion of the Livermore National Lab, CA
- 200 pCi/g for a portion of the Nevada Test Site

Comparison to background radiation: For a second perspective, how do the standards cited above compare to background radiation at Rocky Flats?

- Government agencies say the average background level for plutonium from global fallout in soil along the Front Range of the Rockies in Colorado is 0.04 pCi/g.
- The 50 pCi/g allowed to remain in the top 3 feet of soil at the site is 1,250 times the 0.04 pCi/g average background level.
- The 1,000 to 7,000 pCi/g of plutonium allowed at a depth of 3 to 6 feet below the surface at the site is 25,000 to 175,000 times the 0.04 pCi/g average background level. Below 6 feet at Rocky Flats, there is no limit.
- Plutonium is not a part of natural background radiation. Natural background has been altered globally by the addition of plutonium fallout from the human activity of detonating nuclear devices in the atmosphere.

Comparison to what the public wanted: A third perspective is to look at what the public wanted.

- In June 1995 the DOE-funded broadly representative Rocky Flats Future Site Use Working Group recommended by consensus that the Rocky Flats site be cleaned to the maximum extent possible with existing technology, with the ultimate goal being cleanup to average background level when it becomes technologically and fiscally possible to do this in an environmentally responsible manner.

The public process en route to the final graduated three-level standard

- In 1996, with scant public input, DOE and the regulators (EPA and CDPHE) set the legally binding standard for cleanup of plutonium in Rocky Flats soil at 651 pCi/g. This is 16,275 times the 0.04 pCi/g average background level.
- Due to overwhelming public rejection of this 651 standard, DOE funded an independent study that recommended in February 2000 a 95% reduction from 651 to 35 pCi/g, a number that is 875 times the average background level. It would apply in the soil without respect to depth.
- In response, DOE and the regulators began anew. Finally, in November 2002, they proposed the graduated approach detailed above.

- Meanwhile, those in the public who continued to advocate cleanup to background as the ultimate goal learned that years earlier a closed-door deal had been made with Congress that set a ceiling on how much could be spent on the Rocky Flats cleanup. The three-level approach could be done for the same sum as the rejected 651 approach. Money, not public health or environmental integrity, thus, was the real driver of the Rocky Flats “cleanup.”<sup>16</sup>
- When the agencies put their graduated three-level proposal out for public comment, 86% of the parties commenting rejected what they proposed. This is part of the public record.<sup>17</sup>
- The agencies nevertheless adopted the proposed three-level graduated approach, creating legally binding standards with the final Rocky Flats Cleanup Agreement of June 2003.

The final result: The process for the engaged public had gone full circle from official rejection of the broadly supported 1995 recommendation of cleanup-to-background-as-ultimate-goal through cooptation to rejection again in 2003. By the latter date quite a few from the affected public had more or less willingly gone along with the DOE. Those who expected public participation to mean an opportunity to help design the house of cleanup, however, realized they had simply been allowed to help rearrange the furniture. The final three-layered remediation is better than the old 651 level, because there’s much less plutonium left in the top 3 feet of soil. But to call the end result “safe,” as many government spokespersons do, is a misuse of language.

For those familiar with the Rocky Flats site, here are a few details about what’s left after the “cleanup” in the untouchable depths. At the highly contaminated 903 Pad area, those doing the remediation found that plutonium had percolated down to considerably deeper levels than had been anticipated. Also, though all the large plutonium-processing buildings are gone, the partially cleaned slabs and foundations of some of them were left in place. Ditto for at least 14,700 feet of process waste lines and valve vaults at depths greater than 3 feet. Also, the Solar Evaporation Ponds were not remediated but were backfilled and their contaminated liners were left intact. Each of these contains some plutonium. No one knows how much.

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<sup>16</sup> For detailed discussion, see Moore, “Rocky Flats: The Bait and Switch Cleanup,” *Bulletin of the Atomic Scientists* (Jan./Feb. 2005), on line at <http://www.rockyflatsnuclearguardianship.org/leroy-moores-blog/papers-by-leroy-moore-phd-2/>

<sup>17</sup> See Public Rejects Cleanup Agreement at <http://www.rockyflatsnuclearguardianship.org/required-reading/public-rejects-refuge-access/>

#### 4. WHY THE CLEANUP STANDARDS ARE NOT SUFFICIENTLY PROTECTIVE

DOE and the regulators say the “cleanup” at Rocky Flats is “conservative.” because the standards for permissible exposure to plutonium and other toxins are set to protect a wildlife refuge worker, the person who will spend the most time at the site. But there are numerous reasons why the standards are not sufficiently protective. Consider the following.

Risk-based cleanup and the myth that a little exposure is “safe”: Rocky Flats is an example of what the DOE calls “risk-based cleanup.” The language itself is a tip-off that the “cleanup” is not risk-free. The cleanup standards adopted for Rocky Flats were accompanied by assertions of government officials that the site “cleaned” to these standards is “safe.” Their use of the term “safe” implies that a little radiation can’t hurt anyone. The late Edward Martell, the NCAR radiochemist who opened up the public health question for Rocky Flats when he found plutonium in the off-site environment after the 1969 fire, observed that some people get cancer from naturally occurring radiation. He said further that the small exposures resulting from global fallout from nuclear weapons tests have increased disease and death worldwide. Andrei Sakharov, the dissident Soviet nuclear scientist, said the same thing. We thus should do our best to eliminate risk or to reduce it to the lowest possible level. This principle was not followed in setting the radiation exposure standards for Rocky Flats.

The dubious foundation of radiation exposure standards: The whole edifice of U.S. and international standards for permissible exposure to radiation rests on the dubious foundation of cancer incidence rates among the survivors of the Hiroshima and Nagasaki bombings. But the survivors belong to the strongest, healthiest, most robust part of the population. When a large population is exposed to some toxin, those who die first from this exposure will be the ill, the old, the very young and those with a genetic susceptibility. Basing exposure standards on what happens to survivors results in protecting the strong more than the weak. A better foundation for setting standards would be to use data on nuclear workers.<sup>18</sup>

No safe dose: The National Academy of Sciences report on *Health Risks from Exposure to Low Levels of Ionizing Radiation* (BEIR VII, 2006), the most complete study of this kind to date, categorically affirmed that any dose of radiation is potentially harmful.

An essentially permanent danger: Due to its 24,110-year half-life and the danger of taking tiny particles into the body, any quantity of plutonium left in the Rocky Flats environment poses an essentially permanent danger.

Hazardous in very small amounts: Plutonium particles of 10 microns or smaller can be inhaled. For comparison, the average diameter of human hair is about 50 microns. As reported above (see p. 7 on air monitoring), meteorologist W. Gale Biggs found that airborne particles at Rocky Flats “are probably smaller than 0.01 microns.”<sup>19</sup> Such particles were distributed across the whole of the Rocky Flats site and beyond. Researchers at Columbia University demonstrated that a single plutonium alpha particle induces mutations in mammal cells. Cells receiving very low doses were more likely to be damaged than destroyed. Replication of these damaged cells constitutes genetic harm, and more such harm per unit dose occurs at very low doses than would occur with higher doses. In a follow-up

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<sup>18</sup> Steve Wing, David Richardson and Alice Stewart, “The Relevance of Occupational Epidemiology to Radiation Protection Standards,” *New Solutions*, vol. 9, no. 2 (1999); and Richardson, “Lessons from Hiroshima and Nagasaki: The most exposed and most vulnerable,” *Bulletin of the Atomic Scientists* (May-June 2012) at <http://bos.sagepub.com/content/68/3/10.full.pdf+html>

<sup>19</sup> Biggs, “Airborne Emissions and Monitoring of Plutonium from Rocky Flats,” Feb. 18, 2012 <http://rmpjc.org/rocky-flats/>

study, they found that “a single alpha particle can induce mutations and chromosome aberrations in [adjacent or bystander] cells that received no direct radiation exposure to their DNA.”<sup>20</sup>

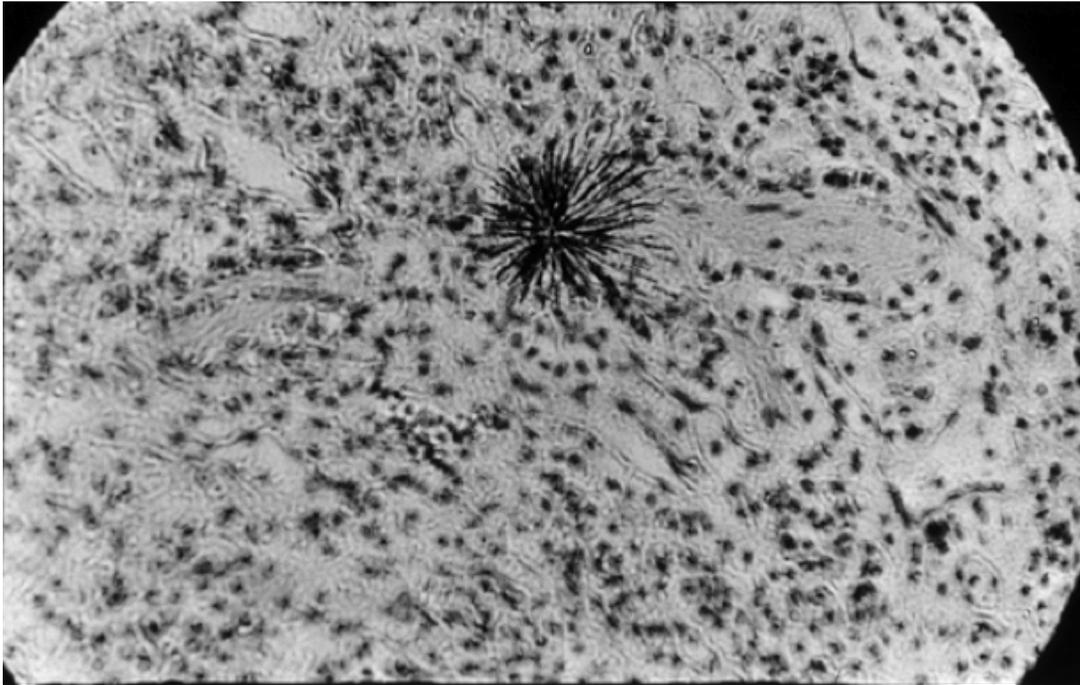


Figure 5. “The black star in the middle of this picture shows the tracks made by alpha rays emitted from a particle of plutonium-239 in the lung tissue of an ape. The alpha rays do not travel very far, but once inside the body, they can penetrate more than 10,000 cells within their range. This set of alpha tracks (magnified 500 times) occurred over a 48-hour period.”<sup>21</sup>

Routine underestimation of potential harm from exposure to plutonium: The alpha radiation emitted by plutonium cannot penetrate skin, but if a particle lodges in the body the alpha radiation it emits is far more harmful than an equal dose from a source of gamma, beta, or x-ray radiation. Because of this, those who set and enforce standards for permissible exposure use a special factor called the “relative biological effect” (RBE) to calculate the extra harm that may result from internal alpha exposure. The RBE number they employ is 20.<sup>22</sup> This means that they assume that plutonium, such as that left in the environment at Rocky Flats, poses a risk of harm 20 times greater than the equivalent dose of radiation emitted by, say, x-rays or the gamma rays emitted by uranium. But 20 is the average RBE. For some individuals the actual RBE will be far greater. The RBE for bone cancer, for example, ranges to as high as 320. For an individual susceptible to bone cancer, therefore, plutonium exposure thus could be 16 times more harmful than exposure allowed if risk is calculated using an RBE of 20. The averaging approach customarily employed by those who set exposure standards disregards the enormous variations in human susceptibility. Further, British researchers recently concluded that the RBE for genetic effects from plutonium exposure is essentially infinite, because the extent of potential harm to the gene pool is incalculable.<sup>23</sup> This review of RBE exposes some of the uncertainty entailed in calculating risk. More importantly it shows that the prevailing way

<sup>20</sup> *Proceedings of the National Academy of Sciences*, vol. 94 (Ap. 1997), pp. 3765-3770; and vol. 98 (4 Dec. 2001), pp. 14410-14415.

<sup>21</sup> Robert Del Tredici, *At Work in the Fields of the Bomb* (NY: Harper & Row, 1987), plate 39.

<sup>22</sup> For discussion and references, see Helen A. Grogan et al, *Assessing Risk of Exposure to Plutonium*, Health Studies on Rocky Flats, Risk Assessment Corp. (CDPHE: Feb. 2000), pp. 6.27-6.39.

<sup>23</sup> M. A. Khadim et al, *Nature*, vol. 355, no. 20 (Feb. 1992), pp. 738-740.

of setting standards for permissible exposure fails by design to protect the most vulnerable people in the population.

Exclusive focus on cancer: Radiation exposure standards are set on the assumption that cancer is the health outcome of greatest concern, when sometimes other health effects outweigh problems associated with cancer. For example, radiation exposure may ruin the mental health of a fetus or infant.

Who is protected? U.S. standards in general are set to protect “reference man,” who is defined by standard-setting bodies as a 154-pound Caucasian male in his twenties.<sup>24</sup> Infants, children, women, the elderly or a fetus are more vulnerable than “reference man” and require better protection, but standards for permissible exposure are generally calculated to protect him, not them. Even the National Academy of Sciences recognizes that women are more vulnerable to ionizing radiation than men, but this fact is not recognized by standard-setting bodies.<sup>25</sup>

Uncertainty: A National Academy of Sciences report published in December 2008 harshly criticizes the EPA for the way it deals with scientific uncertainty in calculating risk. Uncertainty, which stems from lack of knowledge, cannot be eliminated but it can be reduced. Typically EPA treats uncertainty as a sign of the absence of a problem rather than the possible presence of one. “There’s almost an incentive to having scientific uncertainty,” observed one scientist.<sup>26</sup> The NAS report says too little is known about variability in human susceptibility as well as cumulative effects of exposure to radioactive and chemical toxins in combination. The report calls for greater transparency and stakeholder involvement in the risk assessment process.<sup>27</sup> This report on uncertainty points to directions in which the science of risk analysis can be expected to evolve. Meanwhile, however, affected populations at Rocky Flats are expected to live with the results of approaches now criticized by the scientific establishment.

Current radiation standards inadequate: The UK Committee Examining Radiation Risks of Internal Emitters concluded in 2004 that cancer risk from very low-doses of plutonium may be ten or more times more dangerous than allowed for by existing exposure standards. Among other adverse effects, the descendants of seemingly unharmed exposed cells can suffer delayed damage.<sup>28</sup>

“Genetic uncertainty problem” for wildlife: Some observers have taken a very sanguine approach to recent reports that deposits of plutonium have been found in the bodies of deer killed near Rocky Flats. Ecologist K. Shawn Smallwood, who in 1996 studied wildlife at Rocky Flats, “found it remarkable that no genetic studies” had been done there or at other nuclear waste sites.<sup>29</sup> Genetic specialist Diethard Tautz says that effects of radiation exposure on a given species of wildlife may not be readily apparent in the individuals of that species until the passage of several generations. He calls this a “genetic uncertainty problem.”<sup>30</sup> His work suggests that wildlife at Rocky Flats could in the long term be hurt by conditions at the site. Such harm would not be confined to the site.

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<sup>24</sup> Arjun Makhijani, *The Use of Reference Man in Radiation Protection Standards and Guidance with Recommendations for Change*, on line at <http://ieer.org/projects/healthy-from-the-start/>

<sup>25</sup> Mary Olson, “Atomic Radiation Is More Harmful to Women,” available from [www.NIRS.org](http://www.NIRS.org)

<sup>26</sup> Cornelia Dean, “Panel Seeks Changes in EPA Reviews,” *New York Times*, December 3, 2008.

<sup>27</sup> Board on Environmental Studies and Toxicology, National Academy of Sciences, *Science and Decisions: Advancing Risk Assessment* (Washington, DC: National Research Council, 2008). See [http://www.nap.edu/catalog.php?record\\_id=12209](http://www.nap.edu/catalog.php?record_id=12209).

<sup>28</sup> See [www.cerrie.org](http://www.cerrie.org)

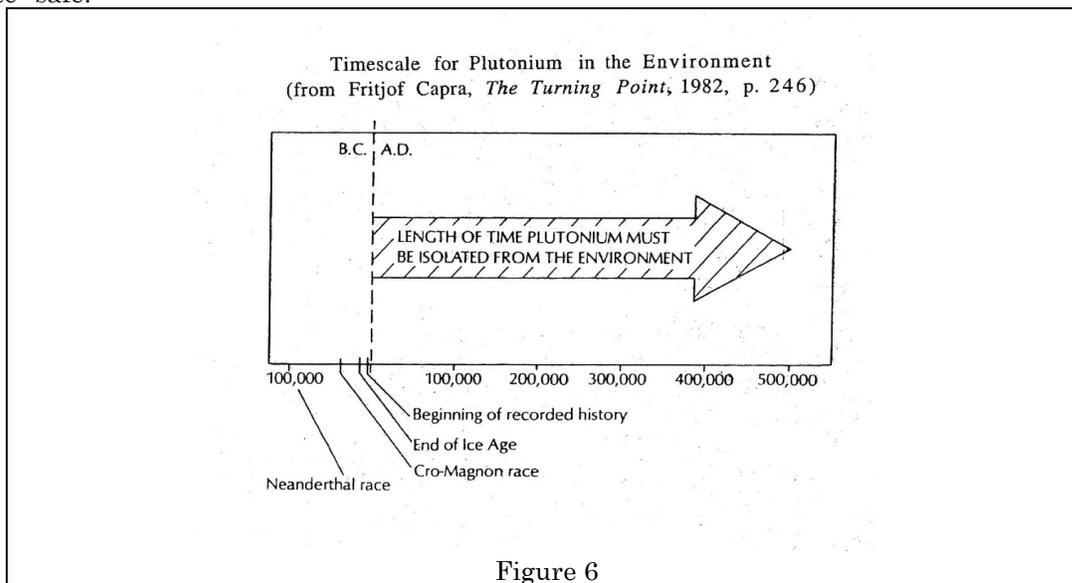
<sup>29</sup> Smallwood et al., “Animal Burrowing Attributes Affecting Hazardous Waste Management,” *Environmental Management*, vol. 22, no. 6, 1998, p. 834.

<sup>30</sup> *Trends in Genetics*, vol. 16, November 2000, pp. 475-477.

Precautionary principle: The Wingspread statement of this principle says, “when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”<sup>31</sup> This principle was flouted by those who set the standards for the “cleanup” at Rocky Flats as well as subsequently by FWS personnel who decided that the public should be allowed access to a site “cleaned” according to these standards.

Affected people excluded from the standard setting process: All standards for permissible radiation exposure are developed by a self-selected scientific elite without any direct input from affected populations, much less their consent. In short, the earthly fate of people is decided not by themselves but by a group that functions like a medieval priesthood.<sup>32</sup>

How long should plutonium be isolated from the environment? University of California physicist Fritjof Capra answers this question with a graphic figure that shows the half-life of plutonium-239 in relation to the timescale of human evolution (see Figure 6). The sad truth at Rocky Flats is not simply that plutonium was never isolated from the environment but was repeatedly deposited there. Moreover, those responsible for the “cleanup” made no effort to clean the site to the maximum extent possible with existing technology. Further, they now call the site “safe.”



<sup>31</sup> <http://www.gdrc.org/u-gov/precaution-3.html>

<sup>32</sup> Lisa Ledwidge, LeRoy Moore and Lisa Crawford, “Stakeholder Perspective on Radiation Protection,” *Health Physics*, vol. 87, no. 3 (Sept. 2002), pp. 293-299.

## 5. THE “CLEANUP” IS BASED ON FAULTY OR INCOMPLETE DATA

The agencies responsible for the “cleanup” at Rocky Flats EPA, CDPHE and DOE ignored some data pertinent to the cleanup and in other cases used incomplete or faulty data.

Data from an investigation of environmental lawbreaking not examined: The FBI raided Rocky Flats in 1989 to collect evidence of alleged environmental lawbreaking by plant operator Rockwell International. A special grand jury spent nearly three years reviewing evidence. When an out-of-court settlement was reached with Rockwell, Judge Sherman Finesilver dismissed the grand jury and sealed documents from the case in the Denver Federal Courthouse. Do these documents contain evidence of environmental contamination that should have been reviewed by those responsible for the Rocky Flats “cleanup”? That the grand jury opposed the settlement and refused to be dismissed until they wrote a report calling for indictment of several Rockwell and DOE officials for illegal activities suggests that such review should have occurred. Yet the EPA and CDPHE, the agencies that regulated the “cleanup,” never reviewed these documents.<sup>33</sup> Wes McKinley, who was foreman of the grand jury and is forbidden by court order from revealing what he learned about environmental conditions at Rocky Flats, decries the fact that the “cleanup” was finished without the public or the regulators having access to the data sealed by Finesilver.<sup>34</sup> Likewise, Jon Lipsky, who headed the FBI investigation, felt betrayed by the sealing of the evidence and the failure to prosecute. The “cleanup,” he says, is “woefully inadequate a farce.”<sup>35</sup> Brian Lipsitt, in a remarkable article about the Rockwell settlement, shows that the Department of Justice settled the case without indicting key individuals for their illegal activity because their illegal behavior was part of a “DOE culture” of lawbreaking. The Department of Justice, by letting these individuals off the hook, allowed them to act above the law. Lipsitt praises the grand jury for daring to go public with their rejection of the settlement.<sup>36</sup>

Map of where waste was deeply buried ignored: Former Rocky Flats worker, Jerry San Pietro says that he was allowed once to see a map that showed where over the years waste had been buried 20 to 30 feet below the surface at various locations on the site. Not only was this map not used in the “cleanup,” soil sampling done for the “cleanup” routinely went no deeper than 6 feet. San Pietro says he was repeatedly rebuffed for his efforts to bring attention to what he had seen. Convinced that a great deal of waste remains deeply buried at the site, he calls Rocky Flats “the largest unlicensed nuclear burial site in the United States.”<sup>37</sup>

False data used: In a paper released at a news conference on August 18, 2004, Jacque Brever, a former Rocky Flats worker and whistleblower in the FBI investigation, said that much of the badly contaminated “East Spray Fields” area at Rocky Flats was excluded from the “cleanup” then nearing completion, because the DOE had knowingly given false information about this area to the regulators.<sup>38</sup> According to Brever, the data DOE should have provided was later revealed in publicly available reports from the out-of-court settlement reached with former contractor Rockwell International in the trial triggered by the 1989 FBI raid. DOE’s response to Brever in this particular

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<sup>33</sup> Anne Imse, “Rocky Flats Brouhaha,” *Rocky Mountain News*, August 20, 2004. For more, see <http://www.rockyflatsnuclearguardianship.org/required-reading/rocky-flats-grand-jury-documents/>

<sup>34</sup> See Wes McKinley and Caron Balkany, *The Ambushed Grand Jury* (NY: Apex Press, 2004).

<sup>35</sup> <http://www.grist.org/article/little-rockyflats/>

<sup>36</sup> Brian Lipsitt, “Rocky Flats: A Plea Bargain in Public View,” in Mary Clifford (editor), *Environmental Crime: Enforcement, Policy, and Social Responsibility* (Gaithersburg, MD: Aspen Publishers, 1998), pp. 397-412.

<sup>37</sup> For San Pietro’s story, see Transcript OH1384v in the Rocky Flats Oral History Collection, Maria Rogers Oral History Program at the Carnegie Branch of the Boulder Public Library. His account of the ignored map was also included in Hannah Nordhaus “The Half-Life of Memory: The Struggle to Memorialize the Nuclear West,” *High Country News*, February 16, 2009.

<sup>38</sup> Brever, “An Analysis of the Department of Energy’s Cleanup Plans for Four Areas at Rocky Flats: The Coverup Continues.” [http://www.utwatch.org/war/jacquebrever\\_rockyflatscleanup.html](http://www.utwatch.org/war/jacquebrever_rockyflatscleanup.html)

matter reiterated rather than refuted the falsehood to which she pointed.<sup>39</sup>

Misleading information about migration of plutonium in soil: Those who designed the “cleanup” for Rocky Flats relied on the team of scientists who did a multi-year Actinide Migration Evaluation at the site and concluded that plutonium in the soil at Rocky Flats remains “relatively immobile.”<sup>40</sup> But their results were based primarily on computer modeling rather than on empirical observation. By contrast, environmental engineer M. Iggy Litaor, with instruments he had set up in the field, in the unusually wet spring of 1995 detected significant horizontal migration of plutonium in shallow subsurface soil at Rocky Flats. Soon after his stunning real-time discovery, which attracted a great deal of attention because it countered the prevailing Rocky Flats orthodoxy, he was involuntarily terminated by Kaiser-Hill and replaced by the Actinide Migration team. Back in his native Israel, he tried for about two years to get DOE-Rocky Flats to provide computerized data he needed to complete a report of his findings. They ignored his request. He thus was never able to publish a report documenting what he had found. Absent such documentation in a technical journal, it’s as if the movement of plutonium Litaor directly observed in the saturated conditions at Rocky Flats in the spring of 1995 never happened.<sup>41</sup> Orthodoxy triumphs truth.

Burrowing animals: In an unprecedented 1996 study, ecologist Shawn Smallwood revealed how burrowing animals redistribute contaminants left in the soil at Rocky Flats. He identified 18 species of burrowing creatures at Rocky Flats, all constantly moving soil and any adhering contaminants. They take surface material down and bring buried material up. Major diggers, like pocket gophers, harvester ants, and prairie dogs, burrow to depths of 10 to 16 feet and disturb very large areas on the surface, while coyotes, badgers, rabbits, and other animals move additional soil. Plants loosen soil and create passages animals can use. Smallwood estimates that burrowing animals disturb 11 to 12% of surface soil at Rocky Flats in any given year. Undisturbed soils do not exist at the site. Plutonium and americium, which at Rocky Flats are only partially remediated down to a depth of 6 feet and are not remediated at all below that level, are being constantly re-circulated in the environment. What’s now buried is likely some day to be brought to the surface for wider dispersal by wind, water, fires or other means. Material brought to the surface in the more contaminated DOE-retained land at the center of the wildlife refuge can be redistributed widely within the refuge and beyond, posing a danger now and in perpetuity. Human and non-human beings will unwittingly take particles into their bodies.<sup>42</sup> In his research Smallwood, who’s located in Davis, CA, went onto the Rocky Flats site on three separate occasions in the summer and fall of 1996, each time accompanied by Rocky Flats personnel. He finished his report before the end of that year and two years later published results in a technical journal.<sup>43</sup> But his findings were totally ignored by

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<sup>39</sup> Joseph A. Legare of DOE responded to Brevier in a September 1, 2004, letter and paper addressed to Steve Gunderson of CDPHE and Mark Aguilar of EPA. He avoided direct response to her allegation that DOE provided false information about the East Spray Fields to the regulators. He neither corrected nor refuted what she had said.

<sup>40</sup> Kaiser-Hill Co., Actinide Migration Evaluation Pathway Analysis Summary Report, ER-108 (April 2004), p. 28. For a more extensive critique of the Actinide Migration Evaluation, see “Science compromised in the Cleanup of Rocky Flats,” on line at <http://www.rockyflatsnuclearguardianship.org/leroy-moore-papers-by-leroy-moore-phd-2/>.

<sup>41</sup> The author possesses a copy of a preliminary report Litaor prepared about his discovery. For references on recent findings of plutonium migration in soil at various sites, see Alexander P. Novikov et al., “Colloid Transport of Plutonium in the Far-Field of the Mayak Production Association, Russia,” *SCIENCE*, vol. 314 (27 October 2006), notes 6 and 8. Research done by Annie Kersting of DOE’s Lawrence Livermore National Laboratory confirms colloidal transport of plutonium. See “Plutonium Hitches a Ride on Subsurface Particles,” *Science & Technology Review*, LLNL, Oct./Nov. 2001, pp. 16-18.

<sup>42</sup> Shawn Smallwood, “Soil Bioturbation and Wind Affect Fate of Hazardous Materials that Were Released at the Rocky Flats Plant, Colorado” (November 23, 1996), Report submitted for plaintiff’s counsel in Cook v. Rockwell International, United States District Court, District of Colorado, No. 90-CV-00181; see also the transcript of Smallwood’s appearance in court in this case, pp. 3912-4130.

<sup>43</sup> Smallwood et al., “Animal Burrowing Attributes Affecting Hazardous Waste Management,” *Environmental*

officials from the DOE, EPA and CDPHE who established the soil remediation standards in the final Rocky Flats Cleanup Agreement of June 2003. Regarding burrowing animals, their analysis was limited to a study of prairie dog activity in the top 6 feet of soil. But they relied primarily on the conclusion of the Actinide Migration Evaluation scientists that plutonium and americium left in the Rocky Flats soil would remain “relatively immobile.” The AME scientists, in their 2004 final report, stated that data on highly mobile species that might transport actinides “are not available and would be difficult and in some cases logistically nearly impossible to obtain.”<sup>44</sup> Smallwood’s study had been completed eight years earlier.

Earthworms: Smallwood did not include earthworms in his study, but they need to be reckoned among the plutonium movers at Rocky Flats. Prof. Tim Seastedt of the Department of Ecology and Evolutionary Biology at the University of Colorado stated what I also heard from others: “To my knowledge, there are no density or biomass estimates for earthworms on the Front Range.”<sup>45</sup> According to my own estimates, the soil at Rocky Flats likely contains at any given time as many as half-a-billion earthworms.<sup>46</sup> One million earthworms weigh a ton, and in a span of 24 hours “each worm will pass through its body its own weight of soil” and its contents,<sup>47</sup> which at Rocky Flats would sometimes include plutonium. Environmental engineer Iggy Litaor, who paid considerable attention to earthworms during his years at Rocky Flats, says that at the site they burrow to a depth of about 50 centimeters (19.5 inches).<sup>48</sup> Each year they may bring to the surface as much as an inch-thick layer of subsoil.<sup>49</sup> Litaor reported that in the saturated conditions of the spring of 1995, when he detected rapid plutonium migration at the site, earthworms surfaced in huge numbers. Various predators devoured many of them, so that whatever contaminants the worms bore within entered their predators’ bodies either to lodge there or to be defecated elsewhere. Untold numbers of the worms dried on the surface and disintegrated into dust that perhaps contained plutonium and americium particles that could be dispersed by wind or other forces. Whenever similarly wet conditions recur at Rocky Flats, similar activity will recur. But, as noted, earthworms otherwise will be constantly bringing plutonium particles to the surface. Those responsible for the “cleanup” at Rocky Flats paid scant attention to this not insignificant reality.

Uptake of plutonium in grass: An eleven-year study done at DOE’s Savannah River Site in South Carolina demonstrates that plutonium in subsurface sediments at that site moved upward from the buried source material. The authors of this study conclude “that the upward movement was largely the result of invading grasses taking up the plutonium and translocating it upward,” producing a “measurable accumulation of plutonium on the ground surface.”<sup>50</sup> By contrast, the AME study at Rocky Flats concluded that “uptake into plant . . . tissues is minor.”<sup>51</sup> The Rocky Flats site consists for the most part of prairie grassland. If grass at the Savannah River Site brings plutonium up to the surface, should we not expect something similar to happen at Rocky Flats? Very likely the grasses at

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*Management*, vol. 22, no. 6, 1998, pp. 831–847.

<sup>44</sup> Kaiser-Hill Co., Actinide Migration Evaluation Pathway Analysis Summary Report, ER-108 (April 2004), p. 23.

<sup>45</sup> Email communication from Tim Seastedt, June 2, 2011.

<sup>46</sup> While earthworm populations per acre “of between one and two million are quite common” ([http://journeytoforever.org/farm\\_library/oliver/balfour\\_intro.html](http://journeytoforever.org/farm_library/oliver/balfour_intro.html)), poor soil may contain only 250,000 per acre (<http://www.experiencefestival.com>). Applying this number to the 6,219 acres of land held by DOE and FWS in 2012 suggests a total earthworm population at the site in excess of 1.5 billion. Dropping this number by two-thirds in order to be exceedingly conservative about the high plains environment at the base of the Rockies puts the number of earthworms at the Rocky Flats site at any given time at upwards of half-a-billion.

<sup>47</sup> [http://journeytoforever.org/farm\\_library/oliver/balfour\\_intro.html](http://journeytoforever.org/farm_library/oliver/balfour_intro.html)

<sup>48</sup> Email communication from M. Iggy Litaor, May 17, 2011.

<sup>49</sup> <http://www.ext.colostate.edu/mg/gardennotes/218.html>

<sup>50</sup> D. I. Kaplan et al., “Upward Movement of Plutonium to Surface Sediments During an 11-Year Field Study, SRNL-STI-2010-00029, January 25, 2010. <http://sti.srs.gov/fulltext/SRNL-STI-2010-00029.pdf>

<sup>51</sup> Kaiser-Hill Co., Actinide Migration Evaluation Pathway Analysis Summary Report, ER-108 (April 2004), p. 28; see p. 24.

Rocky Flats have roots that run deeper into the soil than those at Savannah River, due to the comparably drier climate at Rocky Flats. The question whether the grass at Rocky Flats brings plutonium to the surface presents an uncertainty worth detailed exploration. This appears to be yet one more refutation of the notion that plutonium remaining in the environment at Rocky Flats is “relatively immobile.”

Windblown particles: If, as indicated above, plutonium particles are likely at any time to be blowing in the wind at Rocky Flats, won't air monitors detect them? The answer is no, because air monitoring no longer occurs at Rocky Flats. But even if it did, the answer would still be no (see the discussion of the inadequacy of air monitoring, page 7).

Catastrophic flood: Meteorologist Biggs wonders if at some unforeseen time there might be a flood like the one that long ago deposited the alluvium that became the area known as Rocky Flats. He imagines a torrent rushing down Coal Creek Canyon and washing before it the whole of the gravelly Rocky Flats formation, carrying the contaminants left there to unknown destinations with unimaginable health and environmental effects. His observation is not far-fetched. Climate warming increases the likelihood that mountain pine forests killed by pine beetles will be ignited by lightning into catastrophic fires that denude mountainsides and prepare the way for massive flash floods in the wake of extreme weather. Those who designed the Rocky Flats cleanup made no effort to protect against this sort of interconnected environmental devastation.

Was NEPA violated? The National Environmental Policy Act requires federal agencies undertaking action that significantly affects the human environment to do an Environmental Impact Statement (EIS) for that action. Plans to do an EIS for the Rocky Flats cleanup were canceled on February 25, 1996.<sup>52</sup> Conceivably, the EIS process would have corrected faulty data and uncovered data ignored or overlooked in the “cleanup.”

Conclusion: The “cleanup” done at Rocky Flats endangers uninformed people of future generations. As the foregoing shows, the site was “cleaned” using questionable ways of calculating risk and inadequate data about releases while ignoring important data about site conditions. Though most of the site has legally become a wildlife refuge, it will cease being a wildlife refuge long before plutonium left in the environment ceases to be dangerous. What happens after fences fall and memory fades?

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<sup>52</sup> Ackland, *Making a Real Killing*, p. 240.

## 6. QUESTIONS ABOUT THE ROCKY FLATS NATIONAL WILDLIFE REFUGE

A 2001 act of Congress, co-authored by then-Senator Wayne Allard and then-Representative Mark Udall, mandated creation of the Rocky Flats National Wildlife Refuge upon completion of the Superfund cleanup then underway at Rocky Flats. Accordingly, in 2006, DOE transferred 4,465 acres of land (about 7 square miles) to U.S. Fish & Wildlife Service (FWS) to operate as a wildlife refuge (see Figures 2 and 7).



Figure 7: This sketch of the Rocky Flats National Wildlife Refuge shows FWS plans for entries and trails. The view looks west from Indiana Street toward the Golden-to-Boulder highway with the mountains beyond. The refuge occupies the darker green portion of the site, a total of 4,465 acres (about 7 square miles). The lighter green area in the center of the refuge is the 1,309-acre plot retained by DOE's Legacy Management program; it includes the former industrial zone and more contaminated parts of the site that are subject to ongoing maintenance and engineered controls.

A mixed blessing: Turning a major portion of the former bomb plant site into a wildlife refuge is a mixed blessing. It prevents (for the present at least) residential or commercial development on the site, which is a plus. But at the same time it opened the way to a cheaper "cleanup" that leaves a legacy of far greater risk than if the site had been cleaned to the maximum extent possible with existing technology. People now and into the long-term future are forced to live with the consequences.

Public access? One of the most contentious issues regarding the wildlife refuge is the FWS plan to open it for public recreation. When FWS took comments in 2004 on its Draft Environmental Impact Statement for the refuge, of the 1,280 commenting parties, only 11% explicitly favored public access

while 82% rejected it.<sup>53</sup> The principal reason cited for opposing access was the risk of exposure to plutonium and other toxins left in the environment. In February 2005 FWS nevertheless announced that it will open the refuge for hiking, biking, horseback riding and limited hunting. To date, however, the agency has lacked the funding required to prepare the site for visitors. The refuge thus remains closed.

Informed consent? During the time that he was a Colorado State Representative, Wes McKinley, who was foreman of the grand jury that examined evidence of environmental lawbreaking at Rocky Flats after the 1989 FBI raid on the plant, made several unsuccessful attempts to get a bill passed in the state legislature that would require prominent signs at refuge entry points informing potential visitors that they face risks in visiting the refuge. FWS itself has produced and adopted wording for signs that it intends to post. Each sign will acknowledge that during production years “plutonium and other contaminants were released into the environment.” The signs will further state that an extensive EPA and CDPHE evaluation of contamination shows the following:

“The levels of contamination on refuge land are low, meet conservative state and federal cleanup standards, and are similar to adjacent lands. Both EPA and CDPHE have determined that the land is safe for public recreation, refuge workers, and resident wildlife. The refuge workers, the people most exposed to this environment, have a maximum lifetime increased cancer risk of about 2 in a million due to residual contaminants. Environmental health risks to refuge visitors, including children, are far lower than that.”<sup>54</sup>

This language intended by FWS for signs at the refuge downplays risk, claims safety and rejects informed consent, propounding the official view regarding risk at the refuge. The present paper counters this view by showing, first, that radiation exposure standards are inadequately protective, and, second, that important data about site conditions were not considered in the design of the “cleanup” at Rocky Flats.

Testing for plutonium and americium in respirable dust: Previously (see pages 7-8 above) I referred to the fact that respirable dust in the surface soil on the Rocky Flats site had never been routinely tested for plutonium and americium content, though this method of sampling provides a more accurate assessment of the presence of particles that could be inhaled, the most dangerous way of being exposed. In the spring of 2009 I urged FWS, as the government agency now responsible for the roughly seven square miles of the Rocky Flats National Wildlife Refuge, to hire independent scientists to collect samples of respirable dust from the surface soil at various locations on the site and to have the samples analyzed for plutonium content.<sup>55</sup> I encouraged them to establish a regime to do such testing periodically, because plutonium in soil at the site can be randomly made available to unwitting human subjects by the actions of animals, plants, wind, water and humans. Results from this kind of sampling would, as pointed out above, show to what extent plutonium and americium are present at the time of sampling in breathable particles. FWS rejected this proposal and passed the buck to CDPHE. Having received no response, in an op-ed published on January 10, 2010, I urged CDPHE to establish a permanent program of taking discrete samples of respirable dust from surface soil at Rocky Flats and testing them for plutonium content.<sup>56</sup> Four days later Carl Spreng of CDPHE rejected this proposal, though the op-ed stirred up a wide-ranging discussion.

It will be recalled that my earlier discussion of this topic referred to Carl Johnson and his USGS colleagues who in 1975 tested respirable dust for plutonium content on land east of the Rocky Flats site. Their innovative approach has rarely been repeated anywhere, though in recent years

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<sup>53</sup> <http://www.rockyflatsnuclearguardianship.org/wildlife-refuge/public-rejects-allowing-access-to-the-wildlife-refuge/>

<sup>54</sup> <http://www.fws.gov/rockyflats/Signage/Sign.htm>

<sup>55</sup> “Test the respirable dust at Rocky Flats,” *Boulder Daily Camera*, June 11, 2009.

[http://www.dailycamera.com/ci\\_13124737?IADID=Search-www.dailycamera.com-www.dailycamera.com](http://www.dailycamera.com/ci_13124737?IADID=Search-www.dailycamera.com-www.dailycamera.com&IADID=Search-www.dailycamera.com-www.dailycamera.com)

<sup>56</sup> “Playing with Plutonium at Rocky Flats,” *Boulder Daily Camera*, January 10, 2010.

[http://www.dailycamera.com/ci\\_14151325?IADID=Search-www.dailycamera.com-www.dailycamera.com](http://www.dailycamera.com/ci_14151325?IADID=Search-www.dailycamera.com-www.dailycamera.com)

Marco Kaltofen of the Boston Chemical Data Corp. has done this distinctive type of sampling at Hanford, Los Alamos and Mayak in Russia, all plutonium-contaminated sites.<sup>57</sup> Kaltofen is at the cutting edge of this technology today just as Johnson and his colleagues were in 1975. I recommended to CDPHE that they consider Kaltofen for the Rocky Flats work, but, as noted above, they rejected this recommendation.

Former Rocky Flats workers compared to prospective visitors to the refuge: Colorado Senator Mark Udall and others in Congress have quite appropriately proposed legislation to ensure that former Rocky Flats workers are compensated for ailments due to possible workplace exposure to plutonium and other toxins. Senator Udall and others need to show the same level of care for the wholly innocent unknowing individuals whose health may be harmed if they visit the Rocky Flats National Wildlife Refuge. Potential visitors to the refuge differ from former Rocky Flats workers in several respects.

- They will not be informed that being at Rocky Flats poses a risk.
- No special measures will be taken to protect them.
- No record will be kept of their possible exposures.
- Their future health will not be monitored.
- If their health is harmed due to exposure to plutonium or americium at Rocky Flats, the source of the problem almost certainly will remain unknown.
- No one expects such persons to receive medical care or compensation for their ill fortune.

Of all potential visitors to the wildlife refuge, who is most vulnerable? The answer, most certainly, is a human child, for the following reasons:

- A human child is more likely than an adult to stir up dust, to eat dirt, to breathe in gasps, or to scrape a knee or an elbow, all ways of taking tiny particles of plutonium or americium into the body.
- Since a child's body is smaller than an adult's, internalized plutonium or americium have much less mass in which to be distributed or to concentrate.
- The alpha radiation emitted by plutonium or americium within a child's body integrates with that child's growth and tissue development.
- By contrast to either adult humans or other beings, a child's normal life span provides far more time for internalized alpha radiation to harm her or his health.

On behalf of our own children and on behalf of our grandchildren's children's children, the Rocky Flats Wildlife Refuge should never be opened to the public.<sup>58</sup>

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<sup>57</sup> See <http://naticklabs.org/bcd.html>. For details on his dust sampling activity at radiation-contaminated sites, scroll down on this site to "Biographies" and open the link to "Microanalysis of Heterogeneous Radiation." See also Kaltofen and John Bergendahl, "Microanalysis of Workplace Dusts from the Mixed Waste Tank Farm of the Hanford Nuclear Reservation," *Environmental Engineering Science*, vol. 27, no. 2 (2010).

<sup>58</sup> For more, see <http://www.rockyflatsnuclearguardianship.org/wildlife-refuge/dozen-reasons-to-keep-refuge-closed/>

## 7. THE PROPOSED JEFFERSON PARKWAY

One provision of the act of Congress, that created the Rocky Flats National Wildlife Refuge is that “the Secretary [of Energy], in consultation with the Secretary of the Interior, shall make available land along the eastern boundary of Rocky Flats for the sole purpose of transportation improvements along Indiana Street.” This statement is now being played out by those who want to build the Jefferson Parkway, a privately financed toll highway that would run along the eastern, most contaminated edge of the Rocky Flats site (see Figure 8). The Jefferson Parkway is the latest in a series of efforts to complete the long dreamed-of C-470 beltway around the Denver metro area.

Voters defeated an earlier effort to build a highway adjacent to the Rocky Flats site: By the mid-1980s the only portion of the C-470 beltway that either had not been built or was not then under construction was the northwest portion between I-25 on the north and C-470 in Golden. In April 1987 several local governments created the W-470 Authority to complete the beltway by building a toll road, a section of which, like the proposed Jefferson Parkway, would run along the eastern edge of the Rocky Flats site. In February 1989, in a special election on the issue, the highway was defeated by a four-to-one margin.<sup>59</sup> A key issue for many voters was concern that highway construction would stir up plutonium-laden dust.

The cat comes back: The dream of completing the beltway has as many lives as the proverbial cat that keeps coming back. The portion from I-25 to U.S. 36 in Broomfield was completed as a privately owned toll highway in November 2003. Recently the advocates of build-it-and-they’ll-come urban sprawl created the Jefferson Parkway Public Highway Authority to get the section from U.S. 36 in Broomfield to Hwy. 93 in Golden built as a privately owned tollway. They plan to run the road down Indiana St. through the middle of the most contaminated area on the edge of the Rocky Flats site (see Figure 8).

The question of an Environmental Impact Statement: The National Environmental Policy Act (NEPA) requires that before any agency of the federal government can undertake an action that may adversely affect the environment, it must produce an Environmental Impact Statement (EIS), a detailed analysis showing likely effects of the contemplated action. In 2004, three years before it gained possession of the land that would become the Rocky Flats National Wildlife Refuge, U.S. Fish & Wildlife Service (FWS) conducted an EIS on the refuge, but this EIS totally ignored the question of effects of making the “transportation improvements along Indiana Street” mentioned in the bill that created the refuge.

In the summer of 2012, when the Jefferson Parkway Authority was urging FWS to transfer a 300-foot wide strip of land along Indiana Street for construction of the highway, FWS convened a meeting to hear from the public whether or not it should do an EIS and, if so, what should be included. Of the 100 or so people present at this meeting, not a single one spoke in favor of the highway and all called for a full-fledged EIS to determine the effects on humans and on wildlife of building the highway. In October 2012, without having done an exhaustive study, FWS issued a “Finding of No Significant Impact,” thereby vetoing an EIS and giving itself a green light to transfer land for the highway.

The very next day Golden, Superior and two environmental groups, Rocky Mountain Wild and WildEarthGuardians, filed suit in federal court to require FWS to do an EIS before transferring land for the Jefferson Parkway. Soon thereafter, Golden, having negotiated issues about road construction within its city limits, withdrew from the suit. In December, in response to the remaining three parties, the judge issued an injunction forbidding FWS to transfer any land until the court had examined all details in the case. Two days later, with FWS and others telling the judge that the deal to transfer land would fall through if it wasn’t completed by the end of the day on

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<sup>59</sup> See <http://www.mesalek.com/colo/denvers470.html>

December 31, 2012,<sup>60</sup> the judge suddenly lifted the injunction and allowed FWS to go ahead with the land transfer.

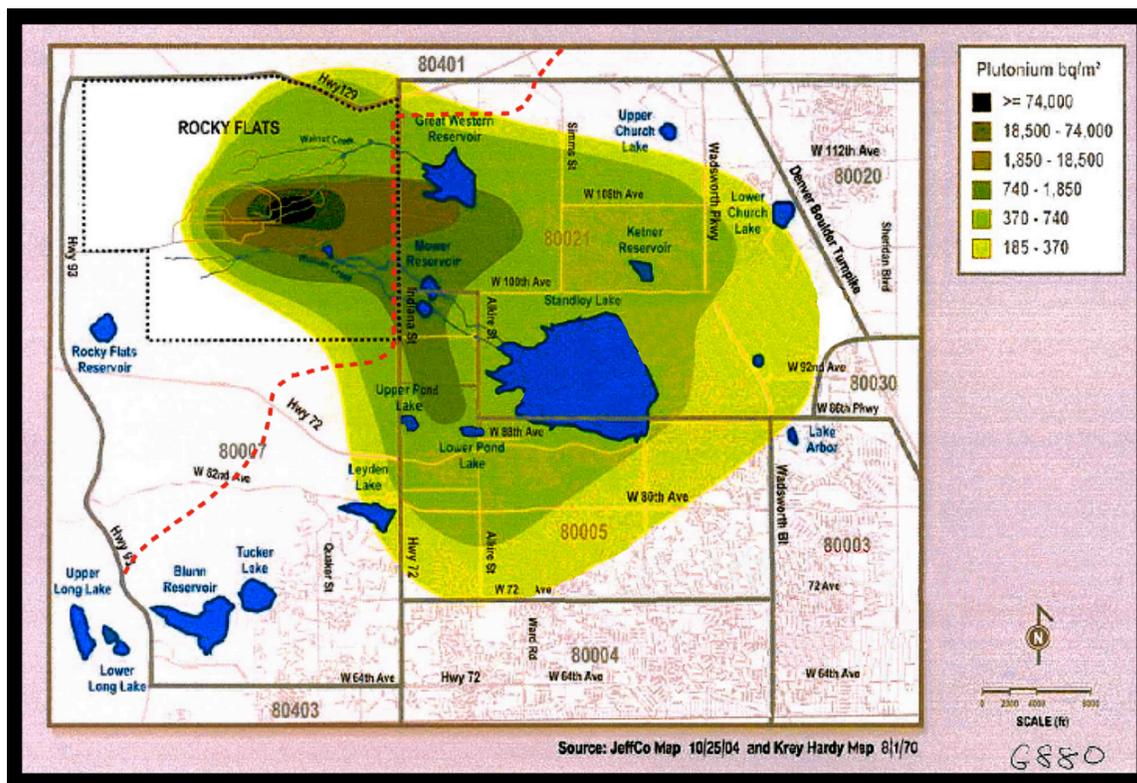


Figure 8: This image is identical to the plutonium contamination map shown in Figure 4 on page 6 except for the addition here of the dotted red line indicating the route of the proposed Jefferson Parkway. As shown, this route passes through the heart of the most contaminated area along the edge of the Rocky Flats site.

Transferring the land, however, didn't annul the lawsuit. Efforts to get the parties to reach an agreement have failed, so the court still must consider the opposing arguments. A ruling in the case is expected some time in the fall of 2013. Though FWS has already transferred land for the Jefferson Parkway, no one knows whether an EIS may yet be required on the matter and, if so, what bearing it will have on the proposed highway.

Civil disobedience? Efforts are still afoot to stop the highway. Civil disobedience has a long and storied history from the years of bomb production at Rocky Flats.<sup>61</sup> If the courts fail to require an EIS on the Jefferson Parkway issue, I foresee a renewal of civil disobedience, this time not to end production but to stop a major highway from being built through an area contaminated with plutonium.<sup>62</sup>

<sup>60</sup> The December 31, 2012, deadline on the land-transfer referred only indirectly to the land FWS ceded to the Jefferson Parkway Authority; it referred specifically to Section 16, a block of State-owned land at the southwest corner of the Rocky Flats site that by the end of 2012 had to be transferred to FWS for incorporation into the Wildlife Refuge (for the location of Section 16, see Figure 2 on page 3).

<sup>61</sup> See Joseph Daniel, *A Year of Disobedience and a Criticality of Conscience* (Boulder: Story Arts Media, 2013).

<sup>62</sup> For more on the Jefferson Parkway issue, see Nicolene Durham, "Hot Particle Politics on the Rocky Flats Road," at <http://www.theboulderstand.org/2013/07/16/hot-particle-politics-on-the-rocky-flats-highway/>

## 8. Residential Development near Rocky Flats

If it's a bad idea to open the still contaminated Rocky Flats site to the public, and if the Jefferson Parkway should not be built along the eastern edge of Rocky Flats because of the danger of plutonium-laden dust, would it not be even more chancy to take up residence near Rocky Flats, especially in downwind areas? Bad idea or not, it is already happening not spasmodically in terms of an isolated house here and there but on the grand scale of large residential developments with hundreds and even thousands of new upscale dwellings.

THIS SECTION IS IN PROCESS. SOME OF THE ITEMS TO BE INCLUDED ARE THE FOLLOWING:

Krey-Hardy sampling and the long history of the question about whether it's safe to live near RF  
Johnson and colleagues from USGS  
HUD requirement from Carter period  
Johnson AMBIO study  
Church lawsuit settlement – CDH role – McKay gets certification from CDH  
CDH soil sampling  
Colo standard for soil sampling  
Grand Jury documents  
Removal of land from Superfund list – problems  
Cook v. Rockwell and Dow  
My correspondence with a resident of the Whisper Creek development (on web site)  
Michelle's action: Candelas Glows and threatened SLAPP suits  
Her solution: Federal purchase of the property

## 9. CONCLUSION: WHAT TO DO ABOUT ROCKY FLATS NUCLEAR GUARDIANSHIP

The preceding pages point to multiple uncertainties about conditions at Rocky Flats. Taken together, they provide a solid foundation for questioning the official dogma that the Rocky Flats National Wildlife Refuge is safe for public recreation. As noted earlier, a recent National Academy of Sciences report criticizes the EPA for too often treating uncertainty as an occasion to throw caution to the wind. Unfortunately, this attitude is widely shared. It is the opposite of the precautionary principle that should prevail when dealing with risk. German critic Ulrich Beck says standards for allowable contamination are “at the same time ‘blank checks’ to poison nature and humankind *a bit*.”<sup>63</sup> Risk-based cleanup like the one at Rocky Flats requires a tradeoff between dollars and disease, which means premature death for some. There is no good reason to continue accepting this tradeoff. What then can be done about Rocky Flats? Other than nothing, there are five options:

- 1) Redo the cleanup in a way that overcomes the impediments of incomplete and faulty data, calculates risk in a cautionary manner, and implements what the public sought in 1995, that is, cleans the site as thoroughly as possible using existing technology, with cleanup to background as the ultimate goal. At present, redoing the cleanup is not feasible politically or economically. Its time will come.
- 2) Establish at Rocky Flats a permanent program of periodic testing of respirable dust for its plutonium and americium content: This step should be taken for both DOE and FWS land regardless of what else is done at the site. Such sampling will show to what extent these materials are accessible to be picked up by wind and carried near and far. The results should be publicly available.
- 3) Provide informed consent to potential visitors to the wildlife refuge: If the refuge is opened, prominent signs should inform people at each entry that visiting the refuge entails some risk. DOE, EPA, CDPHE, FWS and others, including some local governments, oppose this option. Some believe that emphasis on uncertainty and risk at Rocky Flats will hurt economic development in the vicinity. The informed-consent approach has garnered considerable attention at times because it was for several years pursued without success in the Colorado General Assembly by then-Rep. Wes McKinley. We at the Rocky Mountain Peace and Justice Center will support future informed-consent efforts, though for us this is only a halfway house.
- 4) Manage the refuge as open space that is closed to the public: For FWS to take this step would greatly reduce its costs and management responsibilities. Moreover, keeping the refuge closed to the public will do the most that can now be done to protect public health. If infants and children and those in poor health are not allowed to play at Rocky Flats, no one will be taking chances with their lives. Having spectacularly beautiful open space that cannot be visited will help keep alive the memory of Rocky Flats as a local hazard, which is an inescapable aspect of its legacy. Rather than gates and trails, FWS could construct in upwind areas a few overlook platforms that include information about the history of the Rocky Flats plant as well as about the environment and the wildlife. Should the time come when the cleanup is revisited, having an untrammelled refuge will be a benefit.
- 5) Establish nuclear guardianship at Rocky Flats: Rocky Flats provides us with the unique opportunity to initiate nuclear guardianship<sup>64</sup> at a site contaminated with the toxic remains of nuclear bomb production. This can set a positive precedent for other such sites. We

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<sup>63</sup> Ulrich Beck, *Risk Society*, trans. by Mark Ritter (London: Sage Publications, 1992), p. 64.

<sup>64</sup> See <http://www.nonukes.org/r02ethic.htm> and <http://www.rockyflatsnuclearguardianship.org/index.html>

humans are at a turning point in our relation to nature, and one essential aspect of the change is to replace the deadly risk society we have inherited with one of ecological responsibility. Reversing the not-yet implemented FWS decision to open Rocky Flats for public recreation is a fitting first step. It should be accompanied by a program of periodic testing for plutonium and americium in respirable dust in both FWS and DOE areas of the site. The guardian's role is to assume responsibility for a mess we humans have made, curtailing or limiting exposure to toxins while being advocates for the vulnerable and the voiceless, including the non-human creatures that live in or visit the poisoned Rocky Flats environment. Whether such roles should be carried out by government personnel or by others is a question that requires exploration. The need for guardianship will far outlast the typical government agency. Guardianship is a work for the aeons. To implement it requires cooperation between all parties involved. If we do this work well, Rocky Flats can show the way.