

**TESTIMONY TO AGRICULTURE, LIVESTOCK & NATURAL
RESOURCES COMMITTEE OF THE COLORADO HOUSE OF
REPRESENTATIVES, IN SUPPORT OF REPRESENTATIVE WES
MCKINLEY'S HB09-1060, CONCERNING INFORMATION TO BE
PROVIDED TO VISITORS AT ROCKY FLATS, January 21, 2009**

By LeRoy Moore, PhD, 3360 14th St., Boulder, CO 80304

My name is LeRoy Moore. I have been a resident of Colorado since 1974. Until retirement I taught at both the University of Denver and the University of Colorado. I have closely followed all aspects of the Rocky Flats issue since 1979. I am the principal author of the *Citizen's Guide to Rocky Flats*, as well as of a critique of the cleanup published in the *Bulletin of the Atomic Scientists* (Jan./Feb. 2005), plus numerous other writings about Rocky Flat. I am a consultant with the Rocky Mountain Peace and Justice Center, and I served on several advisory bodies related to the cleanup at Rocky Flats. Also, for several years I was a member of two committees of the National Council on Radiation Protection and Measurements, an organization that studies health effects from exposure to radiation.

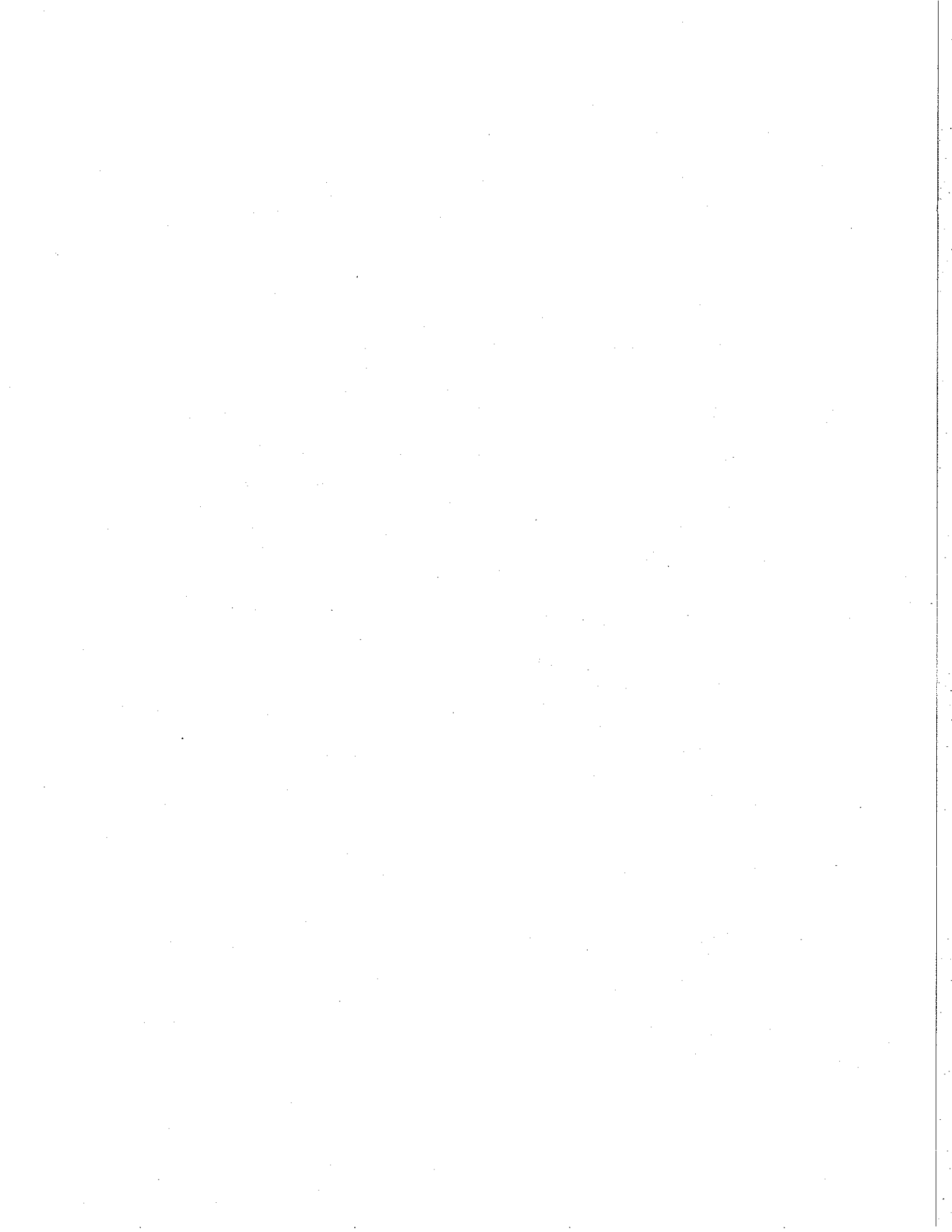
Today I want to address two sets of questions.

1) Why the concern about plutonium? What are the health effects of exposure to plutonium?

It is important to recognize not simply that plutonium in any quantity is exceedingly dangerous, as my testimony will emphasize, but that a large quantity remains in the environment at Rocky Flats because a ceiling was set on how much could be spent on the cleanup.

2) How could exposure to plutonium happen at Rocky Flats? Won't the plutonium left in the soil at Rocky Flats simply stay put?

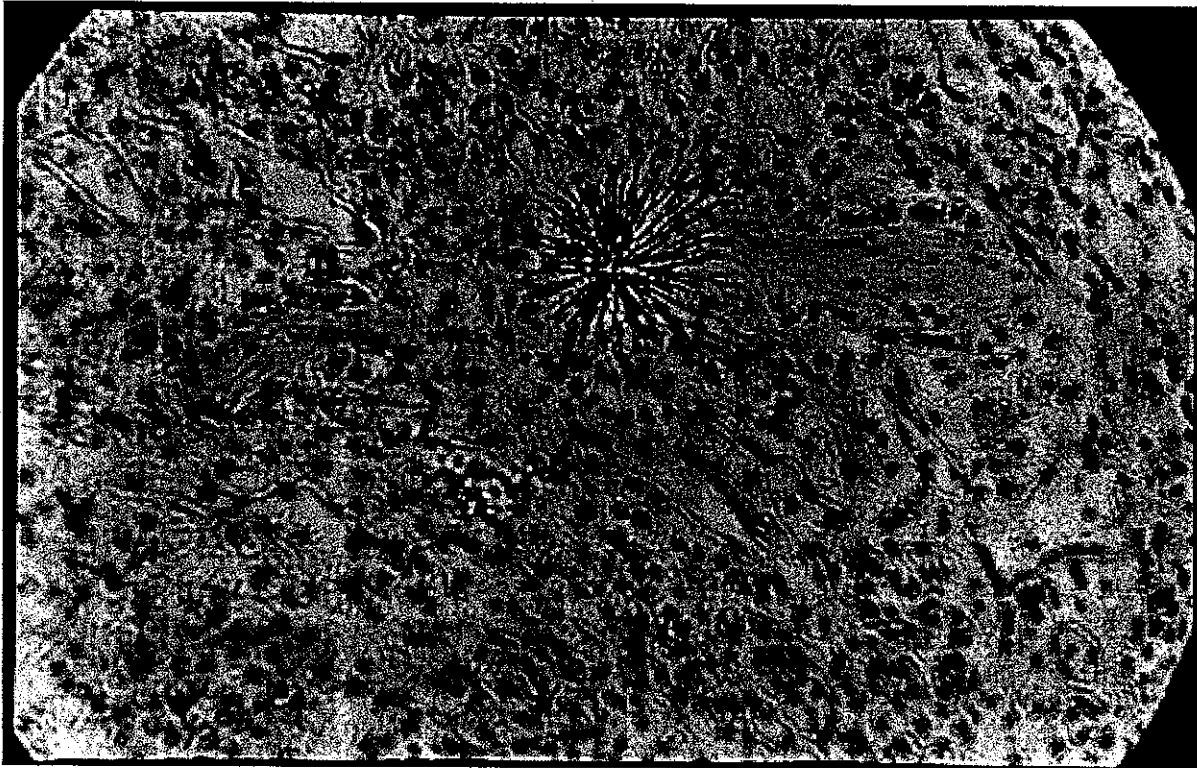
Detailed answers to these two questions are contained in the two attached documents. The first is an April 2008 fact sheet on "Risk from Plutonium in the Environment at Rocky Flats," the second is an op-ed entitled "Keep Rocky Flats closed to the public." that appeared in the Boulder Camera on Saturday, January 17, 2009. The comments I will make during the hearing are drawn primarily from these two sources.



Risk from Plutonium in the Environment at Rocky Flats

Prepared by LeRoy Moore, Ph.D., Rocky Mountain Peace and Justice Center, April 2008)

- **Long-term danger:** Plutonium 239, the contaminant of principal concern at Rocky Flats, has a half-life of 24,110 years. It remains dangerously radioactive for more than a quarter-of-a-million years. Left in the environment, it poses an essentially permanent danger.
- **Lethal quality:** The alpha radiation emitted by plutonium cannot penetrate skin like gamma radiation or x-rays. But tiny particles inhaled, ingested, or taken into the body through an open wound (say, a skinned knee) may lodge in the lungs or migrate to the liver or to the surface or marrow of bone. For as long as it resides in the body it bombards surrounding tissue with radiation. The result may be cancer, genetic defects, harm to the immune system. The latent period for cancer is likely to be 20 to 30 years.



- **Plutonium particle in lung tissue:** "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." (Robert Del Tredici, *At Work in the Fields of the Bomb* [1987], plate 39)
- **Dangerous in very small amounts:** A single microgram of plutonium is "a potentially lethal dose." (F. Albert Cotton & Geoffrey Wilkinson, *Advanced Inorganic Chemistry*, 2nd ed., 1966, p. 1102) As early as 1945 the tolerance limit for plutonium workers was reduced to one microgram. (DOE, *Closing the Circle on the Splitting of the Atom* [1995], p. 38) One microgram = 1/millionth of a gram. One ounce contains 28.5 grams, or 28.5 million micrograms. Particles of plutonium weighing 10 or less micrograms can be readily inhaled.
- **More harmful than other forms of radiation:** Internal alpha emitters like plutonium are much more harmful per unit dose than penetrating gamma or x-ray radiation. To account for the difference, those who try to determine risk from radiation exposure refer to the "relative biological effectiveness" (RBE) of alpha emitters. Looking at the potential harm to different organs and for different disease end-points, the International Commission on Radiological Protection concludes that the average RBE for alpha emitters is 20. This means that, on average, internal alpha emitters are 20 times more harmful than penetrating radiation of the same dose. But because 20 is an average, for some body organs, some cancers and some individuals the actual RBE can be higher, sometimes much higher. For example, the RBE for bone cancer ranges up to 320. Agencies that set standards for permissible exposure to plutonium typically employ in their calculation of risk an RBE of 20. (For discussion and references, see Helen A. Grogan et al, *Assessing Risk of Exposure to Plutonium*, Health Studies on Rocky Flats, Risk Assessment Corporation [Feb. 2000], pp. 6.27-6.39)

- **Incautious approach used in setting Rocky Flats cleanup standards:** Those who set the cleanup standards for Rocky Flats followed the convention of using 20 as the RBE for plutonium. They thereby acted against protecting the most vulnerable members of the population. The resultant Rocky Flats Cleanup Agreement allows 50 picocuries of plutonium per gram of soil to remain in the top 3 feet of soil, much larger quantities at deeper levels. Doubling the RBE to 40 would reduce the 50 picocuries standard for the top 3 feet of soil to 25; each RBE doubling would reduce by half the amount of plutonium allowed in the soil. Because the RBE for bone cancer can be as high as 320, which is 16 times 20, some people exposed to 50 picocuries of plutonium may be 16 times more likely to get bone cancer than the average person.
- **Potential harm to the human gene pool:** A British research team concluded that the RBE for chromosomal damage from plutonium exposure is essentially "infinite," because the extent of harm to the human gene pool is incalculable. (M. A. Khadim et al, *Nature*, vol. 355, no. 20 [Feb. 1992], pp. 738-740) The resultant "genomic instability" may account for illnesses other than cancer, illnesses so elusive that epidemiology is "powerless" to detect any relationship between their incidence and exposure to radiation. (Rob Edwards, *New Scientist*, vol. 11, Oct. 1997, pp. 37-40)
- **Harm from a single particle:** Tom K. Hei and colleagues 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 dose exposures. "These data provide direct evidence that a single alpha particle traversing a nucleus will have a high probability of resulting in a mutation and highlight the need for radiation protection at low doses." In a follow-up study, they found that "a single alpha particle can induce mutations and chromosome aberrations in [adjacent] cells that received no direct radiation exposure to their DNA." (*Proceedings of the National Academy of Sciences*, vol. 94 [Apr. 1997], pp. 3765-3770; and vol. 98 [4 Dec. 2001], pp. 14410-14415)
- **No safe dose:** The National Academy of Sciences report on *Health Risks from Exposure to Low Levels of Ionizing Radiation* (BEIR VII, 2006) categorically affirmed that any dose of radiation is potentially harmful.
- **Current radiation standards inadequate:** The British 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. (See www.cerrie.org)
- **Excess cancers among Rocky Flats workers exposed to purportedly safe levels:** In 1987 Gregg S. Wilkinson of DOE's Los Alamos Lab published results of his study showing that some exposed Rocky Flats workers with internal plutonium deposits as low as 5% of DOE's purportedly safe permissible lifetime body burden developed a variety of cancers in excess of what was normal for workers who had not been exposed. (*American Journal of Epidemiology*, vol. 125, no. 2 [1987], pp. 231-250)
- **"Genetic uncertainty problem" for wildlife:** 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." (*Trends in Genetics*, vol. 16 [Nov. 2000], pp. 475-477) His work suggests that wildlife at Rocky Flats could in the long term be hurt more than helped by conditions at the site. Such harm would not be confined to the site.
- **All the Rocky Flats site contaminated:** Historically, while some areas at Rocky Flats were more heavily contaminated than others, plutonium particles released in fires, accidents, and routine operations were laid down across the whole of the site. Soil sampling done at predominantly upwind locations by F. Ward Whicker of Colorado State University and Harvey Nichols of the University of Colorado supports this conclusion.
- **Extent of contamination unknown, cleanup incomplete:** The government agencies responsible for cleanup of Rocky Flats never thoroughly "characterized" the Rocky Flats site to determine the full extent of contamination in the environment. They also by intent did not clean the site to the maximum extent possible.
- **Harmful form of plutonium left behind:** Plutonium left in the Rocky Flats environment is in the form of very fine particles that can be inhaled or ingested and may be moved by wind, water, plant processes, or the actions of insects, animals, or humans. Ecologist Shawn Smallwood says that up to 12% of the surface soil at Rocky Flats may be disturbed in any given year by animals and insects that burrow to as deep as 16 feet. There is no guarantee that plutonium in the Rocky Flats environment will remain in place or even on the site.

Keep Rocky Flats closed to public

By LeRoy Moore

Change is in the air. One needed change is reversal of plans to open the Rocky Flats National Wildlife Refuge for hiking, biking and picnicking. Why? Because radioactive plutonium left in the environment at the site endangers anyone who visits there.

After completion of the "cleanup" at the defunct Rocky Flats nuclear bomb plant in 2005, the Department of Energy, which ran the facility, transferred almost 4,000 acres of the site to U.S. Fish and Wildlife Service to run as a wildlife refuge. DOE retained about 1,300 more-contaminated acres at the center of the future refuge.

Tiny plutonium particles left in the soil are concentrated in certain areas but otherwise scattered over the whole site. Inhaling, ingesting or taking particles into the body through an open wound could result in cancer or genetic harm. Because plutonium remains radioactive for a quarter-million years the danger is permanent.

Rocky Flats was cleaned in conformity with government standards for permissible exposure. But such standards provide only limited protection. They typically are calculated to protect "reference man" — a 154-pound white male age 20. They do not protect the more vulnerable members of the population — children, infants, a developing fetus, the elderly, those with health problems.

Those responsible for the

Rocky Flats cleanup left in the site's top 3 feet of soil a quantity of plutonium up to 1,250 times local deposits from global fallout. At a depth of 3 to 6 feet they allowed plutonium 25,000 to 175,000 times the fallout level. Below 6 feet they set no limit on what could remain. They relied on scientists who studied plutonium migration at Rocky Flats and concluded that plutonium left in soil at the site would remain "relatively immobile." But their conclusion, which counters recent reports of substantial plutonium migration elsewhere, was based on computer modeling rather than direct observation of the physical environment.

By contrast, just before these scientists were hired, M. I. Litaor, an environmental engineer who'd worked at Rocky Flats for several years, with instruments set up in soil at the site, detected significant plutonium migration during the unusually wet spring of 1995. His finding, he said, called into question the cleanup being planned. He was soon dismissed and denied access to site data he required to complete a full report of his findings.

Those overseeing the Rocky Flats cleanup ignored not only Litaor but also the work of ecologist Shawn Smallwood. In an unprecedented 1996 study he revealed that ants, gophers, and other burrowing animals constantly redistribute plutonium left in the soil at Rocky Flats. They take surface material down and from a depth of 15

or 16 feet bring material up, disturbing in the process 11 to 12 percent of the site's surface soil every year. Minuscule plutonium particles brought to the surface in the more contaminated DOE-retained land at the center of the wildlife refuge can be widely redistributed by wind within the refuge and beyond. This poses a present and future danger to anyone who unwittingly inhales or ingests particles or takes them in through a scraped knee or elbow.

In addition, those who designed the cleanup never saw possible evidence of site pollution contained in documents seized by the FBI in 1989 because these documents remain sealed by court order.

What should concerned parents, teachers, others do? They certainly should not accept FWS plans as a done deal. Back in 2004, 81 percent of those commenting on FWS' proposal to open the future refuge for public recreation rejected the idea. Now we need newly elected Rep. Jared Polis and Sen. Mark Udall to work with us toward the goal of having the Rocky Flats Wildlife Refuge managed as open space that is closed to the public. The author, a concerned grandparent, invites interested parties to contact him at leroymoore@earthlink.net.

LeRoy Moore, a consultant with the Rocky Mountain Peace and Justice Center, is the author of "Citizen's Guide to Rocky Flats."

